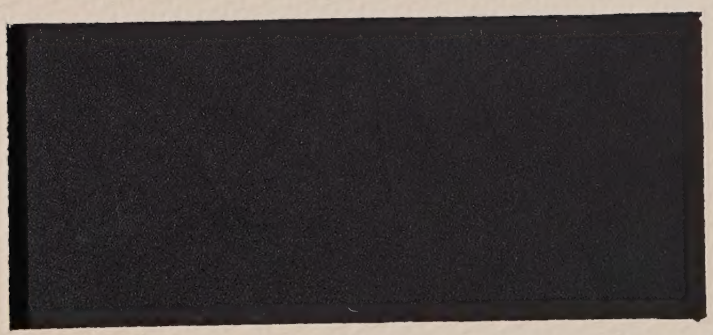
narda *Microline*®

INSTRUCTION MANUAL

PRECISION MICROWAVE AND RF TEST EQUIPMENT

THE NARDA MICROWAVE CORPORATION, PLAINVIEW, L.I., N.Y. 11803 • 516 GE 3-9000



THE NARDA MICROWAVE CORPORATION

TECHNICAL MANUAL
OPERATING AND MAINTENANCE INSTRUCTIONS

FOR

MODEL 66A3A
PEAK POWER METER

TM 3 - 67022-66A3A

March, 1967

WARRANTY

THE NARDA MICROWAVE CORPORATION

Warrants each instrument of its manufacture to be free from defect in material and workmanship. The limit of liability under this warranty is to repair and replace any instrument or part thereof which shall, within one year after delivery to the original purchaser, and returned by the orginating purchaser, prove to be defective after examination by us. However, this warranty specifically excludes tubes or transistors, fuses and batteries. Warranty returns must first be authorized by factory office or representative.

The NARDA Microwave Corporation also reserves the right to make changes in design on any of its products without incurring any obligation to make the same changes on units previously purchased.

This warranty is the extent of the obligations or liabilities assumed by The NARDA Microwave Corporation with respect to its instruments, and the NARDA Microwave Corporation neither makes nor authorizes any other person to make any other guaranty or warranty concerning these instruments.

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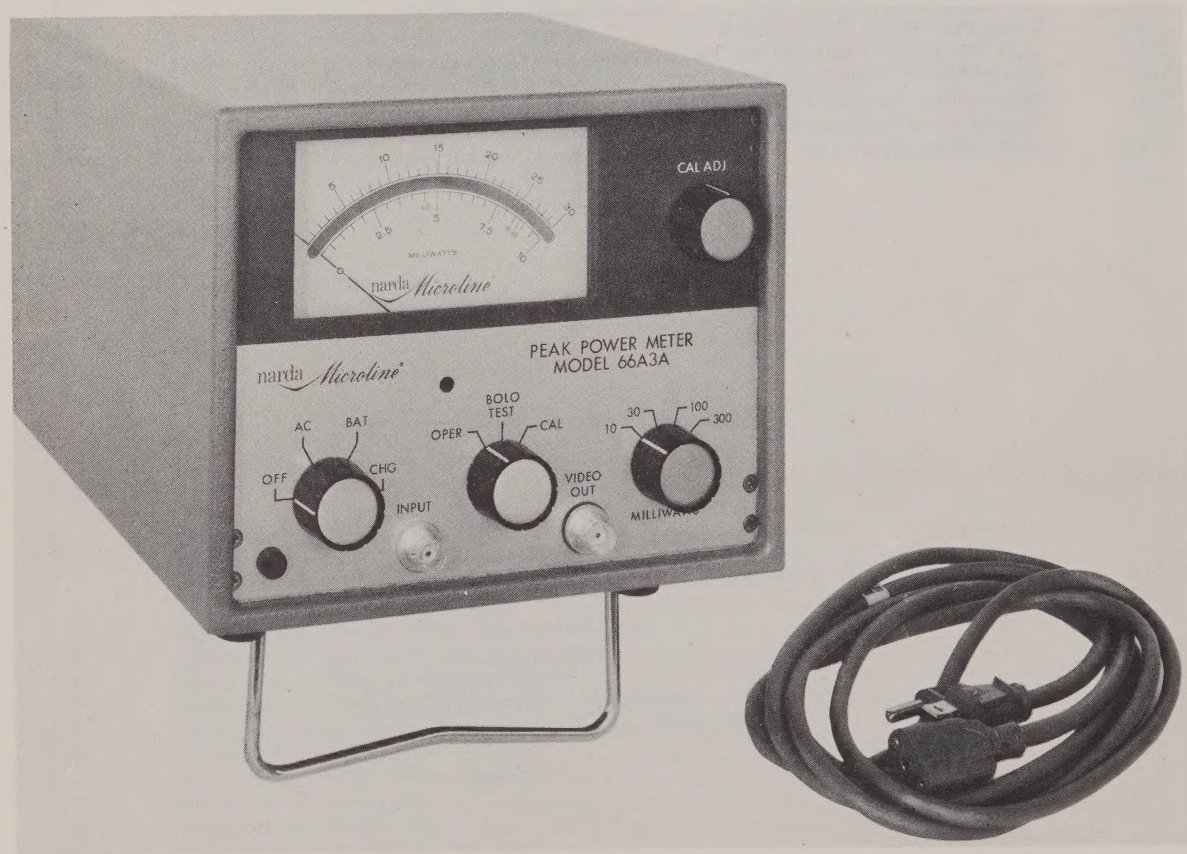


Figure 1-1. Narda Microline Model 66A3A Peak Power Meter

SECTION I

GENERAL DESCRIPTION

1-1. INTRODUCTION

1-2. This manual contains instructions for the use and maintenance of the Narda Microline Model 66A3A Peak Power Meter designed and manufactured by the Narda Microwave Corporation, Plainview, L.I., New York. The manual includes a general description of the equipment, installation and operating instructions, theory of operation, maintenance data and a replaceable parts list.

1-3. PURPOSE AND USE OF EQUIPMENT

1-4. The Narda Microline Model 66A3A Peak Power Meter (figure 1-1) hereinafter referred to as the Power Meter, is a completely transistorized precision instrument capable of r-f peak power measurements from 1.5 to 300 milliwatts. Measurement accuracy is independent of pulse width and repetition rate in the ranges of 0.25 to 10.0 microseconds and 50 to 10,000 cps respectively. Both coaxial and waveguide accessory mounts are available to cover a wide frequency range. An optional battery pack can be used for portable operation where ac line power is not available.

1-5. One of the most important features of the Power Meter is its design for intended use in radar environments. Particular care has been exercised in the shielding of critical components and circuits against the effects of ambient microwave energy.

1-6. The Power Meter is also designed to provide several application features. A front panel VIDEO OUT jack provides a restored video pulse whose characteristics are nearly identical to the r-f pulse applied to the bolometer. Thus, measurement of the video pulse width and repetion rate is equivalent to measurement of the r-f pulse characteristics. The VIDEO OUT jack can also be used to determine the presence of extraneous interference, or to provide a sampling point of the video pulse for self test of the Power Meter.

1-7. Provision is also included for applications requiring a dc driving voltage. A rear panel RECORDER jack provides a d-c voltage output which is proportional to the peak power measured. This output can be used to drive a recorder for making permanent records, or to drive any remote indicator or alarm for monitoring or control.

1-8. The Power Meter is an extremely stable instrument and no drift shou.d occur, even during long periods of measurements. The Power Meter is zeroed on the highest power range scale. With this setting, zero-set is maintained on all other Power Meter ranges. Thus re-zeroing of the Power Meter is not necessary when the power measurement range is changed.

1-9. Calibration of the Power Meter is based upon previous measurements of the pulse sensitivity characteristics of the bolometer employed and the use of a calibrating signal which permits adjusting the amplifier gain to match the sensitivity of the bolometer. An internal calibrator generates three different ramp slopes, each based upon a standard-established 30 milliwatt r-f peak power input when loaded with an impedance equal to that of the Power Meter input. Calibration of the meter is easily performed by adjusting the front panel CAL ADJ control for full scale deflection of the meter. A rear panel BOLOMETER SELECTOR switch provides simultaneous selection of proper bias voltage and calibrator ramp slope for the bolometer being used. The front panel meter face is also provided with bias calibration marks for use when adjusting bias voltage for the particular bolometer selected. Bias calibration marks are indicated by 8.75 and 4.5 ma marks.

1-10. The Power Meter is completely transistorized, minimizing power consumption; it may be operated from 115/230-volt power lines from 50 to 440 cps, or from an optional internal, rechargeable battery. When the battery is installed, it is automatically trickle-charged during ac operation. The battery may also be charged at a higher rate after battery operation.

1-11. EQUIPMENT SPECIFICATIONS

1-12. Table 1-1 provides a listing of pertinent electrical and mechanical specifications of the Power Meter.

1-13. EQUIPMENT SUPPLIED

1-14. An 8-foot power cable assembly is supplied with the Power Meter for connection of the unit to a line voltage source of 115 or 230 vac. (See figure 1-1.)

1-15. A rechargeable nickel cadmium 24-volt battery pack is available as an optional accessory to permit continuous Power Meter operation up to 8 hours in areas where ac power is unavailable. Other optional accessories include the Narda Microline Model 33B3 coaxial Bolometer Mount and 33( )2 series of Waveguide Bolometer Mounts. (See figure 1-2 and Table 1-1.)

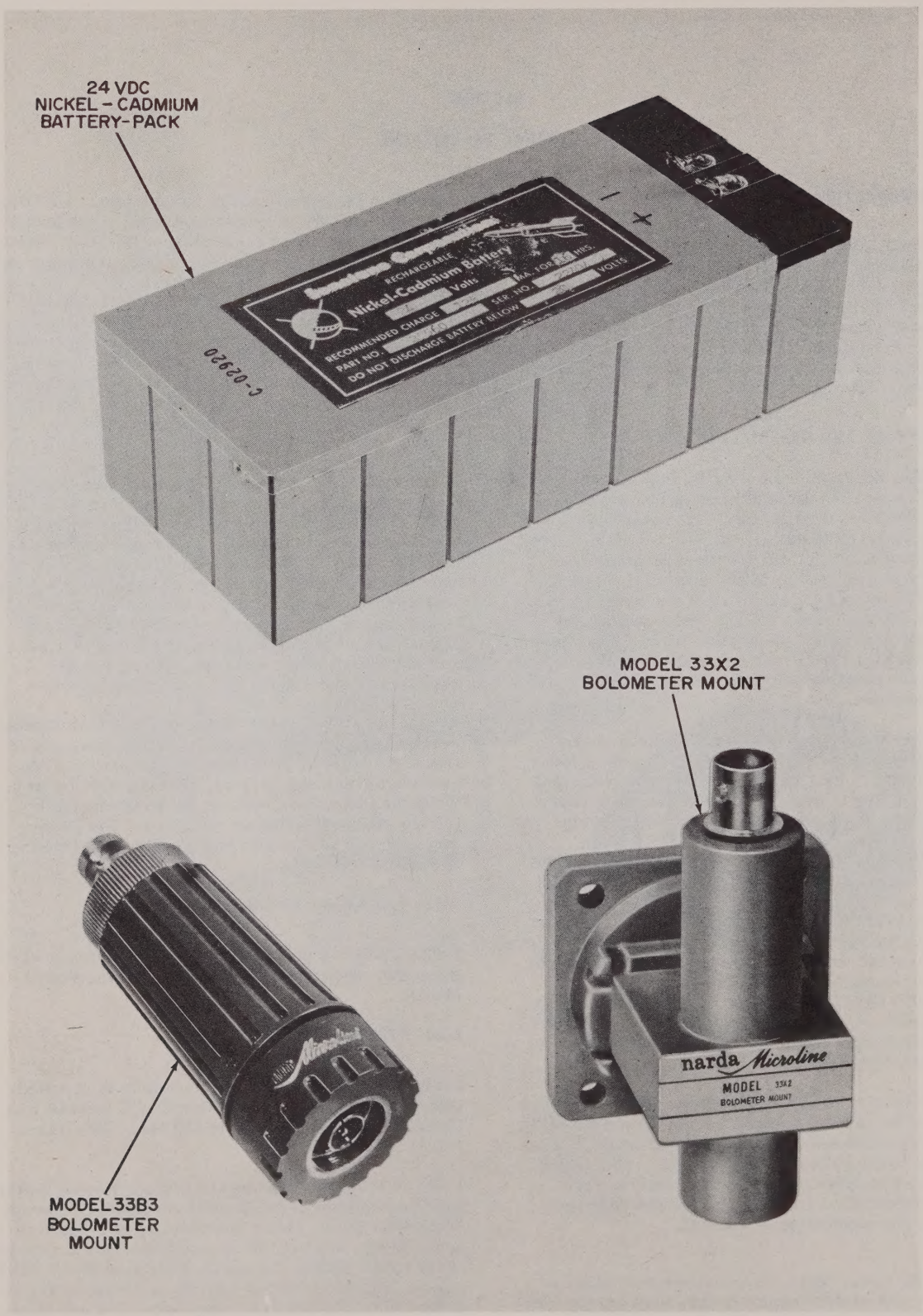


Figure 1-2. Optional Accessories for Power Meter

Table 1-1. Equipment Specifications

Power Range	4 ranges: 10 mw, 30 mw, 100 mw, 300 mw	
Bolometer Mounts (Optional):	Model	Frequency Range (GHZ)
Coaxial	33B3	0.5 to 10.0
Waveguide	33S2	2.6 to 3.95
	33C2	3.95 to 5.85
	33G2	5.85 to 8.2
	33H2	7.05 to 10.0
	33X2	8.2 to 12.4
Repetition Rates	50 H_Z to 10 KH_Z	
Pulse Widths	0.25 to 10.0 usec.	
Accuracy	All ranges, ±5% of full scale at 10°C to 55°C	
Recorder Output	1.5 volts dc at full scale across 1500 ohms	
Video Output	1.5 volts peak at full scale.	
Power Supply	115 or 230 vac ±10%, 50 to 440 cps, 1.5 watts; or battery pack (optional)	
Dimensions:		
Height	6-1/2 inches	
Width	7-3/4 inches	
Depth	12 inches	
Weight	Net 8.0 pounds, 11 pounds (approx.) with battery pack	

1-16. PRINCIPLES OF OPERATION

1-17. The Power Meter is a portable measuring instrument designed to provide accurate r-f peak power measurements independent of pulse width and repetition rate. A unique bolometer integration-differentiation technique is utilized to obtain direct readings of peak power in either rectangular or non-rectangular pulses. An r-f pulse applied to the bolometer is integrated into a ramp whose length is equal to the pulse width and whose slope is proportional to the peak power. The ramp function is then differentiated into a video pulse. The video pulse width is equal to the r-f pulse width and the video peak amplitude is proportional to the r-f pulse peak power. The video pulses are then peak detected, converting the video pulse amplitude to a dc analog voltage. This voltage is applied to a metering circuit calibrated directly in peak power.

1-18. The ultra-stable zeroing circuit seldom requires resetting under normal ambient temperature variations. Calibration is accomplished easily and rapidly with an extremely accurate internal calibrator.

1-19. SEMICONDUCTOR, FUSE AND LAMP COMPLEMENTS

1-20. Table 1-2 provides a listing of the transistor and diode complement of the Power Meter; table 1-3 lists the fuse and lamp complement.

Table 1-2. Transistor and Diode Complement

Ref. Designation	Type	Quantity
Q1, Q3, Q4, Q5, Q13, Q104, Q105, Q203	2N834	8
Q2, Q106, Q202	2N964	3
Q6, Q7, Q8, Q10, Q11, Q12	2N2270	6
Q9	2N1479	1
Q201	2N3964	1
CR2	1N3022A	1
CR3	1N645	1
CR4, CR14, CR203	1N914	3
CR5, CR6, CR7, CR8, CR9	1N538	5
CR10	1N963B	1
CR11, CR201	1N754	2
CR12	1N823	1
CR13	1N270	1
CR15, CR204	1N457	2
CR16	1N753A	1
CR202	1N758	1

Table 1-3. Fuse and Lamp Complement

Ref. Designation	Type	Quantity
F1	0.25A, 125V	1
DS1	NE-2	1

SECTION II

INSTALLATION AND OPERATION

2-1. GENERAL

2-2. The Power Meter is shipped complete and ready to operate; no special installation procedures are required unless a fixed station or system type of installation is contemplated.

2-3. UNPACKING THE EQUIPMENT

2-4. Upon receipt of the Power Meter, perform a preliminary visual inspection of the carton for evidence of damage during transportation. Any evidence of serious damage should be reported to the carrier prior to unpacking the equipment.

NOTE

Retain the shipping container for reuse, if later reshipment is anticipated.

2-5. If there is no evidence of damage, unpack the equipment, following conventional unpacking procedures and using care.

2-6. PRELIMINARY INSPECTION

2-7. The power meter was tested and inspected at the factory before shipment. Immediately after unpacking the equipment visually inspect it for damage which may have occurred in transit, such as broken knobs, scratches on panels, damaged meter, etc. Following the visual inspection, check the Power Meter electrically using the procedure in paragraph 2-20. If there is any evidence of damage, immediately file a claim for damage in transit with the carrier. Refer to paragraph 2-35 for general instructions on packing for reshipment.

2-8. INSTALLATION

2-9. After checking the unit visually and electrically, plan its installation. In most instances, the Power Meter will be employed for bench or cart use; in this case, a permanent space should be provided, either on the bench or in the cart, for storage of the Mounts. This space should be padded with foam or other thick material to minimize jarring or shocks to the bolometer elements and thus preserve Mount life and calibration.

2-10 PREOPERATIONAL PROCEDURES

2-11. Procedures for preparing the Power Meter for operation are discussed in paragraphs 2-12 through 2-24 which follow.

2-12. FUNCTIONS OF OPERATING CONTROLS, INDICATORS AND CONNECTORS.(See figure 2-1.) Operating controls, indicators and connectors of the Power Meter are shown in figure 2-1, and their functions are listed in table 2-1.

2-13. SETUP FOR AC OPERATION. For ac operation, the Power Meter is supplied with an accessory detachable three-conductor power cable. This cable terminates in a polarized three-prong male connector at one end and in a female connector at the other end. The offset round pin of the male connector is connected to the chassis of the equipment for the ground connection. Make certain that the 115V/230V slide-switch on the rear panel is in the proper position before connecting the Power Meter to an ac source.

2-14. It is the recommendation of the NEMA (National Electrical Manufacturer's Association) that all exposed parts of this type of equipment be grounded for the protection of using personnel. When connecting the three-prong connector to a two-contact outlet, a three-prong to two-prong adapter should be used with the green lead on the adapter being connected to ground.

2-15. To convert the Power Meter from 115-volt operation to operation from a standard 230-volt ac source, move the slide-switch on the rear panel to the 230V position. It is not necessary to change the fuse when switching to 230 vac operation.

2-16. SETUP FOR DC OPERATION. The optional battery for the Power Meter is a rechargeable 24-volt nickle-cadmium type. If purchased with the Power Meter, the battery is installed at the factory before shipment. If purchased separately, the battery is supplied with a mounting kit and complete installation instructions.

2-17. For battery operation of the equipment, use the following procedure:

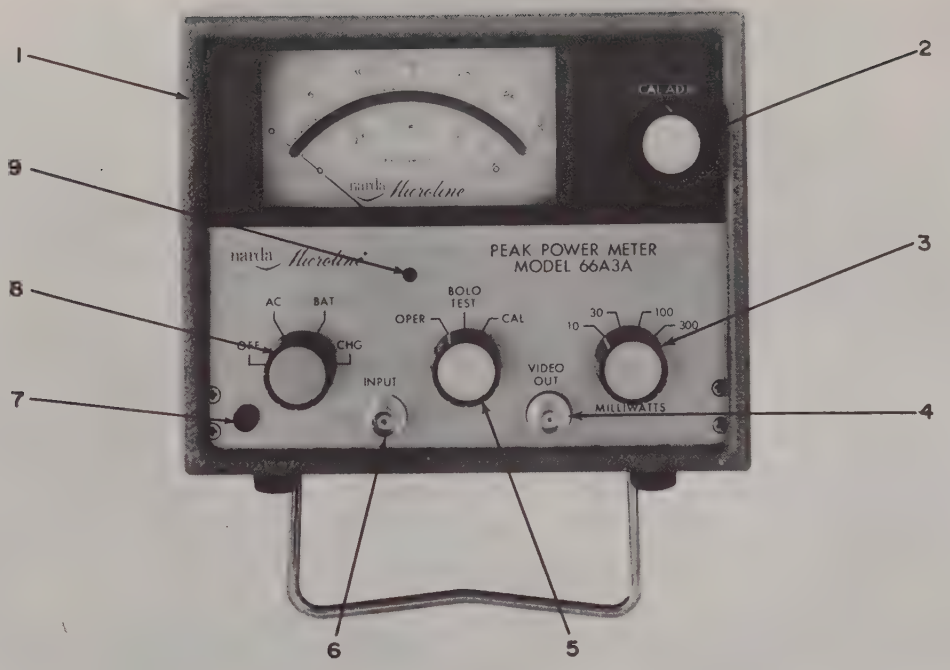
a. Connect Power Meter to an ac source using power cable supplied with equipment. Set OFF-AC-BAT-CHG Power Selector switch on front panel to CHG and charge battery for a minimum of 16 hours.

b. Be sure Power Meter is operating normally by using normal ac operating procedure given in paragraph 2-24.

c. Set Power Selector switch to BAT (the power lamp is extinguished); readjust ZERO setting and apply r-f power using appropriate procedure given in paragraph 2-27.

NOTE

Further instructions on the use and recharging of the battery are presented in paragraph 2-28.



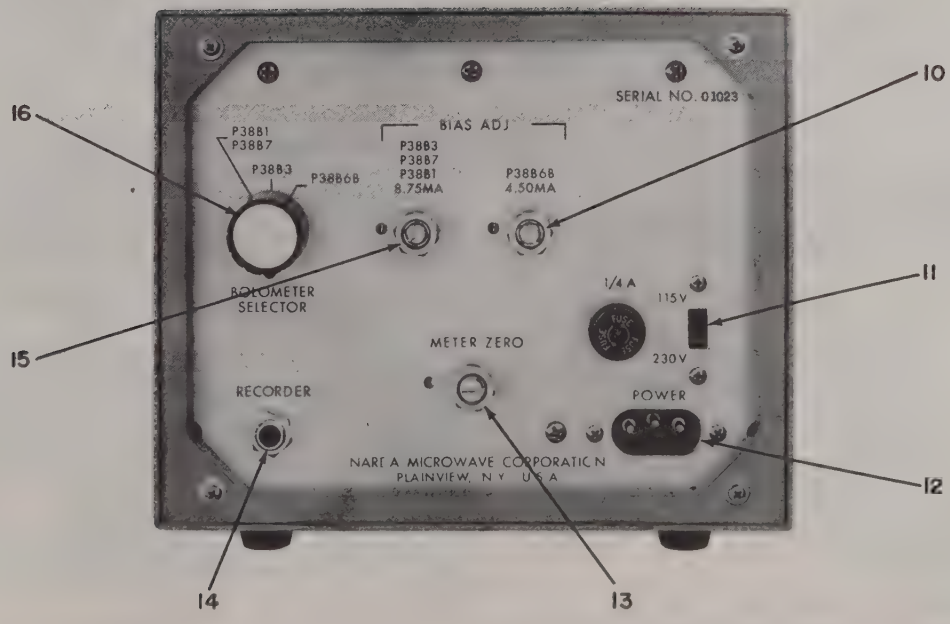


Figure 2-1. Power Meter Operating Controls, Indicators and Connectors

Table 2-1. Functions of Operating Controls, Indicators and Connectors

Figure 2-1 Index No.	Control, Indicator or Connector	Function
1	Meter	Displays peak power reading of r-f peak power applied to Mount.
2	CAL ADJ control	Provides calibration of meter for full scale deflection.
3	Range Selector switch	Four position switch controls full scale reading on meter.
4	VIDEO OUT connector	Provides restored pulse of r-f pulse applied to Mount.
5	Function Selector switch	Three-position rotary switch for selection of the following: 1. OPER - Mode of operation for measurement of peak power. 2. BOLO TEST - Mode of operation for testing of bolometer bias current. 3. CAL - Mode of operation for calibration of meter for full scale deflection.
6	INPUT connector	Provides Power Meter input connection for Mount in use.
7	Power lamp	Illuminates when power selector switch is set to AC or CHG positions only.
8	Power Selector switch	Four-position rotary switch for selection of the following: 1. OFF - No power, ac or battery, applied to Power Meter. 2. AC - Selects 115- or 230-volt, 50 to 440 cps input power; power lamp illuminates and trickle charge is applied to battery. 3. BAT - Selects internal 24-volt battery as power source for unit operation; ac input circuit is disabled. 4. CHG - Selects 115 or 230 vac input power for battery charging only; power lamp illuminates but Power Meter is inoperative.
9	Meter zero control	Provides mechanical adjustment of meter zero setting.
10	BIAS ADJ (4.5 ma) (control)	Provides adjustment of bias current for 4.5 ma bolometers.

Table 2-1. Functions of Operating Controls, Indicators and Connectors (Cont)

Figure 2-1 Index No.	Control, Indicator or Connector	Function
11	115V/230V switch	Slide-switch to allow Power Meter to operate from an ac line source of 115 or 230 volts when set to appropriate position.
12	POWER connector	Provides Power Meter line connection to 115- or 230-volt ac source through 7-1/2-foot power cable.
13	METER ZERO control	Provides electrical adjustment of meter zero setting.
14	RECORDER jack	Provides capability of monitoring amplified dc voltage proportional to r-f peak power on recorder or other external equipment.
15	BIAS ADJ (8.75 ma) (control)	Provides adjustment of bias current for 8.75 ma bolometers.
16	BOLOMETER SELECTOR switch	Provides selection of proper bias and calibration voltages for bolometer used.

2-18. CONNECTING BOLOMETER MOUNT. Mount connection to the Power Meter is made through an RG-58/U coaxial cable with BNC male connectors. One end of the cable is connected to the BNC female connector on the Mount and the remaining end to the INPUT BNC connector on the Power Meter front panel.

2-19. PREOPERATIONAL ADJUSTMENTS. Before peak power measurements can be made, the Power Meter must be zeroed and calibrated in order to achieve the specified accuracy. Also, the Bolometer Mount must contain an appropriate Peak Power Bolometer.

NOTE

Bolometer Mounts are normally supplied with average type Bolometers from the factory. For Peak Power measurements, an appropriate Peak Power Bolometer must be purchased separately from the factory and the average type Bolometer replaced. See Section IV for replacement of Bolometer element.

2-20. Zero Adjustment. The metering circuit must be adjusted for zero both mechanically and electrically before making r-f peak power measurements. The following procedure is used for zero adjustments.

NOTE

Meter zeroing must be performed without Bolometer Mount connected and should be accomplished on the 300 milliwatt scale; meter zero will then hold for all other scales.

a. Turn power selector switch to OFF. Check that panel meter reads zero. If it does not, zero it mechanically by following adjustment procedure in Section IV.
b. Turn power selector switch to AC or BAT as desired.
c. Turn function selector switch to OPER.
d. Turn range selector switch to 300.
e. Adjust METER ZERO control on rear panel until panel meter indicates zero.

2-21. Calibration Adjustment. The Power Meter must be calibrated for the Bolometer type being used before making r-f peak power measurements. The following procedure is used for calibration adjustment.
a. Set BOLOMETER SELECTOR switch on rear panel to position corresponding to Bolometer type being used. Table 2-2 lists Bolometers and Bolometer Mounts for various frequency ranges and provides the correct setting of BOLOMETER SELECTOR switch and appropriate BIAS ADJ control.
b. Connect Bolometer Mount to INPUT connector on front panel.
c. Turn power selector switch to AC or BAT as desired.
d. Set function selector switch to BOLO TEST and adjust BIAS ADJ control (8.75 or 4.5 ma) for selected Bolometer(until meter indicates proper bias (meter needle centered over bias calibration mark).
e. Set function selector switch to CAL and adjust CAL ADJ control for full scale meter deflection.
f. Set function selector switch to OPER and connect Bolometer Mount to measurement setup.

Table 2-2. Bolometer Mount Characteristics

Frequency Range (GHZ)	Bolometer Mount	Peak Power Bolometer Type*	Bias Adj (ma)
2.6 to 3.95	33S2 34S1	P38B3 P38B1 P38B7	
3.95 to 5.85	33C2 34C1	P38B3 P38B1 P38B7	
5.85 to 8.2	33G2 34G1	P38B3 P38B1 P38B7	
7.05 to 10.0	33H2 34H1	P38B3 P38B1 P38B7	
8.2 to 12.4	33X2 34X1	P38B3 P38B1 P38B7	
0.5 to 10.0	33B3	P38B6	

*Corresponds to rear panel BOLOMETER SELECTOR switch position.

2-22. Measurement Precautions. Observe the following precautions to prevent damage to the instrument and to ensure proper operation:

a. Never apply excessive power to the bolometer. To measure peak power greater than 300 milliwatts, insert a calibrated attenuator or directional coupler between the source and Bolometer Mount.

b. Never operate the instrument outside of its shielded case.

c. Never reset the range selector switch to a lower range until it is certain that the range is adequate for peak power to be measured.

d. Avoid mechanical shock to Bolometer Mount.

e. Avoid scratches on flange or dirt in waveguide Mount.

2-23. The Power Meter is an extremely stable instrument and no drift should occur, even during long periods of measurement. However, the zero adjustment and calibration adjustment procedure of paragraphs 2-20 and 2-21 should be repeated periodically to make certain that controls have not been changed accidentally. These adjustments should also be repeated each time a different Bolometer Mount is used. Readjustments are not required when the range selector switch is changed.

2-24. OPERATING PROCEDURES

2-25. The following instructions cover both ac operation and dc operation of the Power Meter. The Power Meter should be properly adjusted for calibration and zero-setting prior to making r-f power measurements. These instructions include measurement information and precautions to be observed.

2-26. Ac Operation. To operate the Power Meter from an ac source, proceed as follows:

a. Make certain that 115V/230V slide-switch on rear panel is in correct position before making any connection to power source.

b. Plug power cable into rear of unit and attach to ac source.

c. Set BOLOMETER SELECTOR switch on rear panel to proper position for Bolometer and Mount in use. (See table 2-2.)

CAUTION

Avoid mechanical shocks to Bolometer Mount. Avoid dirt and scratches on flange; avoid dirt in waveguide Mount.

d. Connect Mount to Power Meter.

e. Turn off r-f power.

f. Check mechanical meter zero (Power Meter off).

g. Set power selector switch to AC. The power indicator lamp will illuminate.

h. Set range selector switch to highest range (300 milliwatts) and zero meter with METER ZERO controls. (Refer to paragraph 2-20.)

CAUTION

Never apply excessive power to Bolometer. To measure power at levels above 300 mw insert a calibrated attenuator or coupler between source and Mount. (See figure 2-2.)

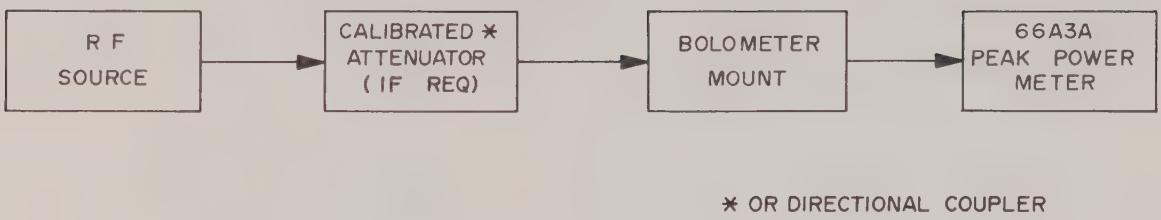


Figure 2-2. Peak Power Measurement Setup

2-27. Dc Operation. The procedure for dc operation is the same as for ac operation discussed in the preceding paragraph, except that the Power Selector switch is set to BAT to turn on the Power Meter.

CAUTION

Never operate with a discharged battery. The battery may be damaged by excessive discharge. Allow two hours charging for each hour of use.

2-28. BATTERY USE AND CHARGING. To obtain maximum life from the battery, avoid discharging or nearly discharging it. When it is necessary to operate from the battery supply for a long period, make certain to charge the battery in the ratio of approximately two charging hours for each operation hour. When the nickel-cadmium battery is fully charged it can supply power for 8 hours of continuous operation, if required. Such a continuous operating period should be followed by a 16-hour charging period.

CAUTION

Whenever there is an indication of low battery, immediately stop operation and recharge the battery. Damage to the battery may result if it is discharged further or remains discharged.

2-29. Low Battery Indications. When it is impossible to zero-set, or the zero-set is changing rapidly while operating on battery, it is generally an indication that the battery needs recharging.

2-30. Battery Charging. Use the following procedure to charge the internal battery:

a. Set 115V/230V switch for nominal voltage of ac power source.

b. Check that power cable set is properly plugged into POWER input connector and attach power cable to ac source.

c. Set power selector switch to CHG position; the power lamp should illuminate, indicating that battery is charging.

d. Record time battery was placed on charge for future reference.

e. Charge two hours for every hour of previous use.

2-31. USING POWER METER SPECIAL FEATURES. The Power Meter furnishes a voltage (0 to 1.5 vdc) at the RECORDER jack, which is proportional to the peak power measured. In addition, the VIDEO OUT jack provides a restored video pulse (i.e., the differentiated ramp voltage from the bolometer). These additional output features provide a measurement system with broad capabilities. Some of the more useful of these measurement systems are illustrated in block diagram form and discussed in the following paragraphs.

2-32. Making Permanent Records. Attach the recorder to the Power Meter as shown in figure 2-3.

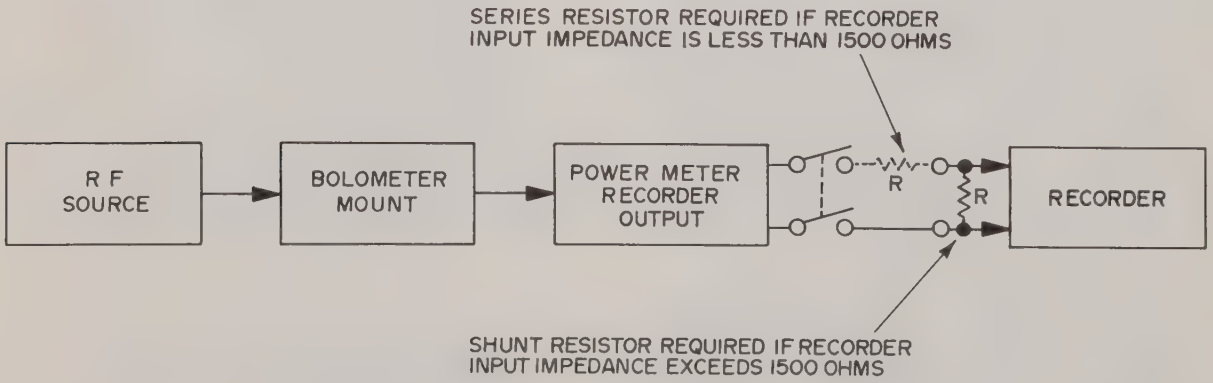

SERIES RESISTOR REQUIRED IF RECORDER INPUT IMPEDANCE IS LESS THAN 1500 OHMS
R F SOURCE
BOLOMETER MOUNT
POWER METER RECORDER OUTPUT
R
R
RECORDER
SHUNT RESISTOR REQUIRED IF RECORDER INPUT IMPEDANCE EXCEEDS 1500 OHMS

Figure 2-3. Application of Power Meter Recorder Output

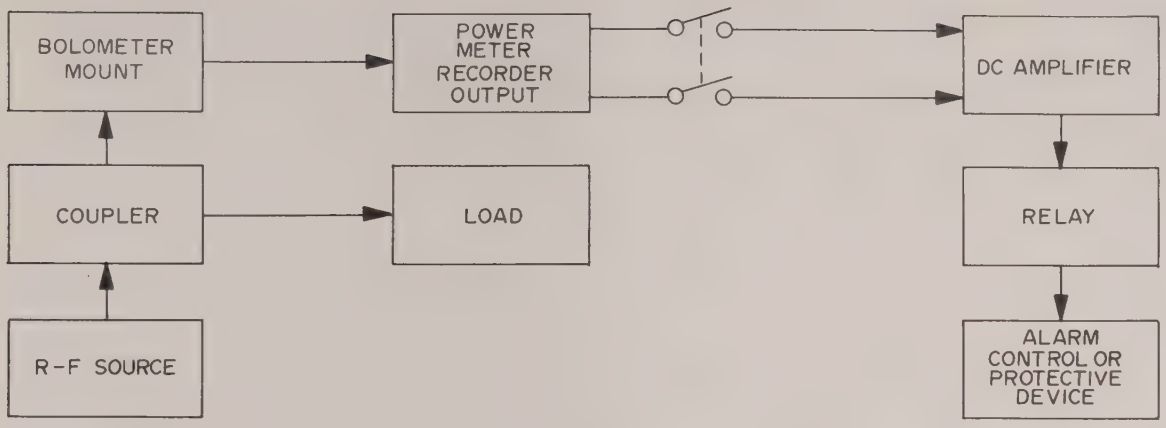


Figure 2-4. Power Meter Monitor Control Application

Although any type of recorder may be used with the Power Meter, the input impedance presented to the RECORDER output jack must be maintained at 1500 ohms. The input impedance should not be less than 1500 ohms in order to prevent damage to the internal meter. A resistor in series with the recorder input must be used to adjust the input impedance to 1500 ohms minimum. If the recorder input impedance is greater than 1500 ohms, the internal meter will no longer give a true indication of peak power being measured; therefore, a shunt across the recorder input may be used to adjust the impedance to 1500 ohms.

2-33. Attaching Monitoring or Control Systems. The Power Meter RECORDER output can be used to automatically control or turn off an r-f generator while unattended, or trip an alarm at a predetermined power level. (See figure 2-4.) A dc amplifier, with an input impedance of 1500 ohms ±1% and an adjustable threshold, is connected to the RECORDER output jack. A suitable relay circuit, controlled by the dc amplifier, controls an alarm or protective device. If desired, simultaneous recording of power can be made with the recorder setup illustrated in figure 2-3; however, the total load impedance for the RECORDER output jack must always be kept at 1500 ohms ±1% to retain the accuracy of the Power Meter and protect the meter movement from burnout.

2-34. Pulse Width Measurement. Illustrated in figure 2-5 is a system which provides accurate measurement of video pulse width. Pulse Width, coding, and prf may be checked while simultaneously measuring peak power. The display on the oscilloscope can also be used to examine the pulse train for missing or spurious pulses.

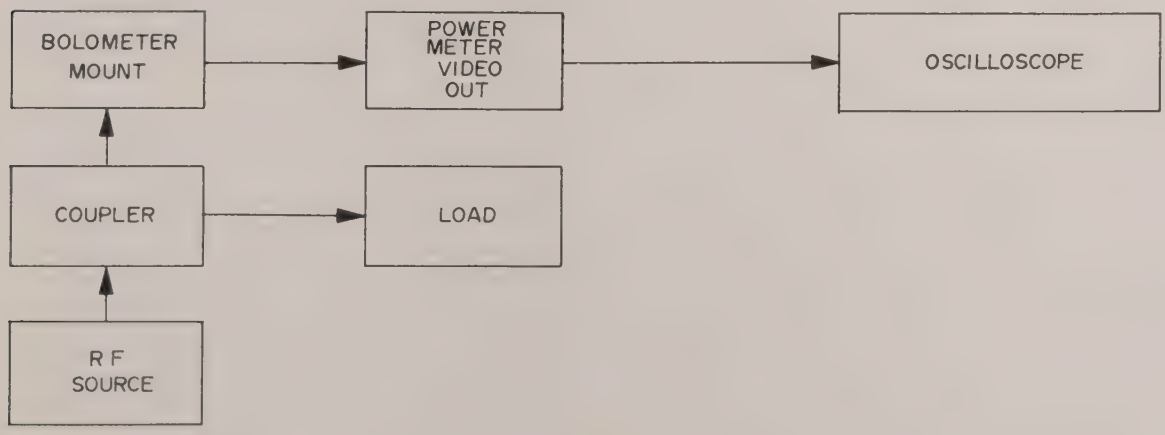


Figure 2-5. Pulse Characteristics Measurements

2-35. RESHIPMENT

2-36. If possible, in the event the Power Meter was damaged during shipment, or if the equipment requires repair, use the original packing container and materials. If a substitute shipping container is used for reshipment, make certain that is has strong cardboard or wooden sides and heavy wrappings. The Power Meter should be surrounded by ample padding when placed in the container. After packing, the container should be clearly marked "FRAGILE" and "DELICATE INSTRUMENT" on the surfaces.

SECTION III

THEORY OF OPERATION

3-1. GENERAL

3-2. This section presents an analysis of the circuits incorporated in the Power Meter and is divided into two basic parts: the first portion concerns itself with a general description of the bolometer integration-differentiation method of peak power measurement; the second portion is a description of Power Meter circuits referenced to simplified schematic diagrams as applicable.

3-3. PRINCIPLES OF BOLOMETER INTEGRATION DIFFERENTIATION TECHNIQUE

3-4. Paragraphs 3-5 through 3-8 discuss the principles relating to the bolometer integration-differentiation technique of peak power measurement.

3-5. The basis of the integration-differentiation technique is that any waveform may be integrated and the resulting waveshape differentiated to restore the original waveform. The accuracy with which this can be accomplished depends on how accurate the integrating and differentiating processes are. This, in turn, depends on the elements envolved in the process and the range over which they are required to operate.

3-6. The integrator is a bolometer, the microwave detector element itself, selected for a specific resistance change per milliwatt per microsecond. In peak power measurement, this quantity is termed the bolometer sensitivity. Several types of Narda microline bolometers are selected for peak power measurement.

3-7. A better description of the bolometer integration-differentiation technique can be given by reference to the waveforms associated with the operation, illustrated in figure 3-1. The input r-f pulse, figure 3-1a, is applied to the bolometer. As the r-f power is absorbed, bolometer resistance increases since its temperature increases; the waveform of figure 3-1b appears as the bolometer output. This signal is the integral of the original r-f power waveform and after differentiation in the Peak Power Meter, the original waveform is restored (figure 3-1c). This is the true power envelope, and a peak detector can be used to indicate peak power directly. In figure 3-1a, a rectangular pulse is shown for simplicity, however, in practice the pulse can be any shape, since the integration-differentiation process is independent of waveshape.

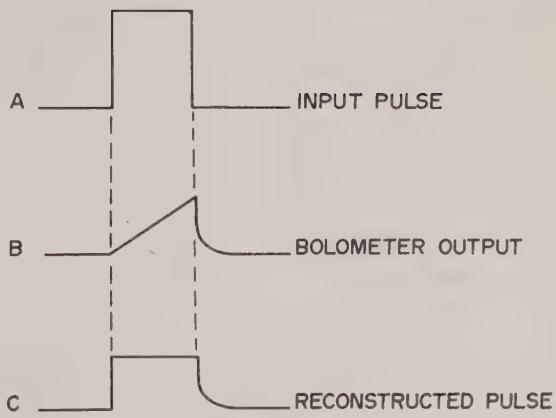


Figure 3-1. Bolometer Integration-Differentiator Waveforms

3-8. When used with appropriate bolometers and bolometer Mounts, the Narda Microline Model 66A3A Peak Power Meter produces a dc analog voltage that is directly proportional to the peak power impressed on the bolometer. The dc analog voltage is applied to metering circuits for front panel display and to a jack on the rear panel for recording or other purposes.

3-9. FUNCTIONAL DESCRIPTION OF POWERDWER METER CIRCUITS

3-10. The Power Meter circuits are discussed in paragraphs 3-11 through 3-33 which follow.

3-11. BLOCK DIAGRAM DESCRIPTION. Figure 3-2 is a block diagram of the Peak Power Meter. When r-f energy is applied to the bolometer, the bolometer temperature changes, causing a corresponding change in bolometer resistance. The bias circuit applies bias to the bolometer causing it to produce a ramp waveform in accordance with the change in resistance. The slope of the ramp is proportional to the peak power input, due to the time required for the bolometer to heat. An internal calibrator provides a calibrated ramp voltage to the power measuring circuits to calibrate the meter for various bolometer ramp characteristics.

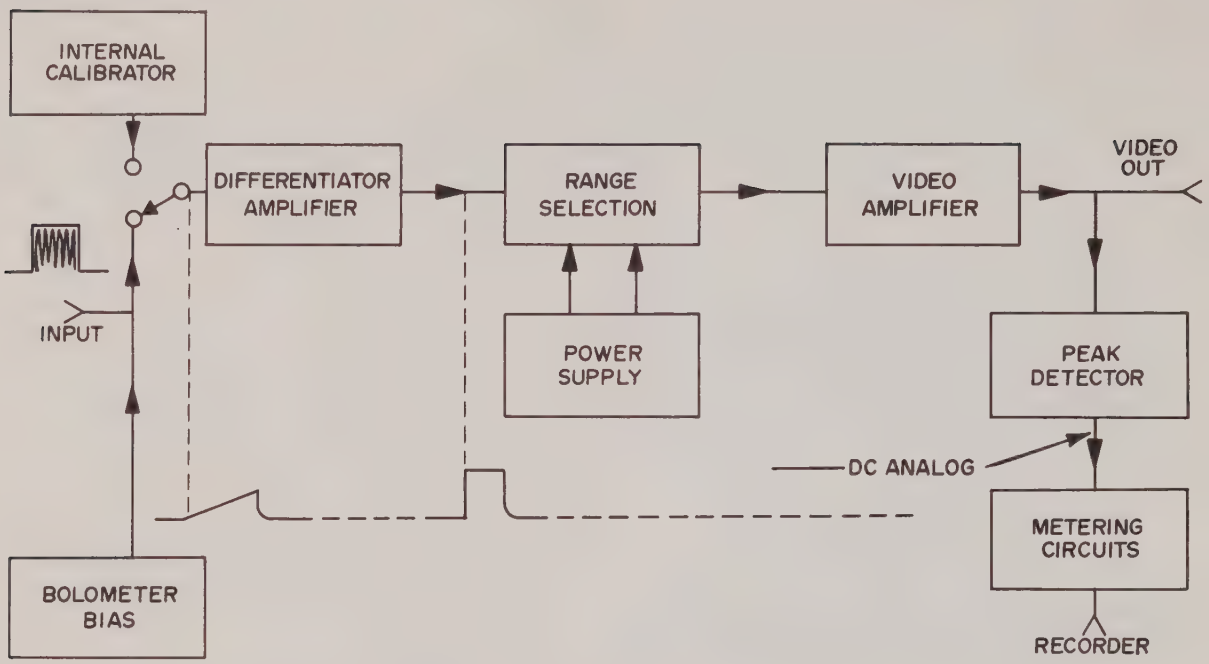


Figure 3-2. Narda Microline 66A3A Peak Power Meter, Block Diagram

3-12. The bolometer output is then applied to the differentiator amplifier. This circuit differentiates the bolometer output and produces a video pulse whose amplitude is proportional to the peak power input. The video pulse is amplified and applied to the range selection network. The video pulse is then further amplified and applied to a peak detector and to the front panel VIDEO OUT jack for monitoring and control applications.

3-13. Pulses entering the peak detector are applied to a gate circuit. The gate circuit controls a monostable multivibrator which produces a standard current pulse each time it fires. The current pulses from the monostable multivbirator are used to charge a capacitor. A portion of the voltage on the capacitor is used as feedback to the gate circuit. When the amplitude of the feedback voltage applied to the gate circuit equals the amplitude of the video pulses from the differentiator-amplifier, the peak detector has reached a stable level. The gate circuit then closes and prevents pulses from triggering the monostable multivibrator. The monostable multivibrator requires about 35 random triggers per second to maintain a stable level for any given video pulse peak amplitude. This circuit allows measurement of peak power independent of pulse width and prf.

3-14. CIRCUIT DESCRIPTION. A detailed description of the Power Meter circuits is presented in paragraphs 3-15 through 3-33 which follows. The discussion is referenced to simplified schematic diagrams, as applicable, and to the overall schematic diagrams in Section IV.

3-15. Differentiator-Amplifier. (See figure 3-3.) The bolometer ramp enters the differentiator-amplifier and is applied to the base of transistor Q201 through capacitor C202 which differentiates the ramp. The resulting pulse has a width corresponding to the length of the ramp and an amplitude proportional to the slope of the ramp. Transistors Q201 and Q202 form a low gain, temperature stable, negative feedback amplifier circuit which amplifies the differentiated ramp. The negative feedback amplifier presents a very low impedance to the differentiating capacitor at all times.

3-16. The output of transistor Q202 is ac coupled to the emitter of transistor Q203, a grounded base amplifier. Diode CR204 acts as temperature compensation for transistor Q203 so that a constant bias level is maintained over a wide temperature range.

3-17. Resistor R230, diode CR201, and capacitors C206 and C215 form a regulator circuit to drop the +18.5 volt B+ to 6.8 volts for the amplifier. Capacitors C206 and C215 function as a filter to prevent noise from entering the amplifier.

3-18. Range Selector Circuit. (See figure 3-4.) The range selector circuit consists of the range switch, a series of precision resistors, and the bias network of transistor Q104 which functions as a voltage divider. The range selector switch taps a voltage from this divider and applies it to the base of transistor Q104 in the video amplifier. The voltage across the divder is varied by the potential on the collector Q103, which is proportional to the amplitude of the video pulse from the differentiated ramp.

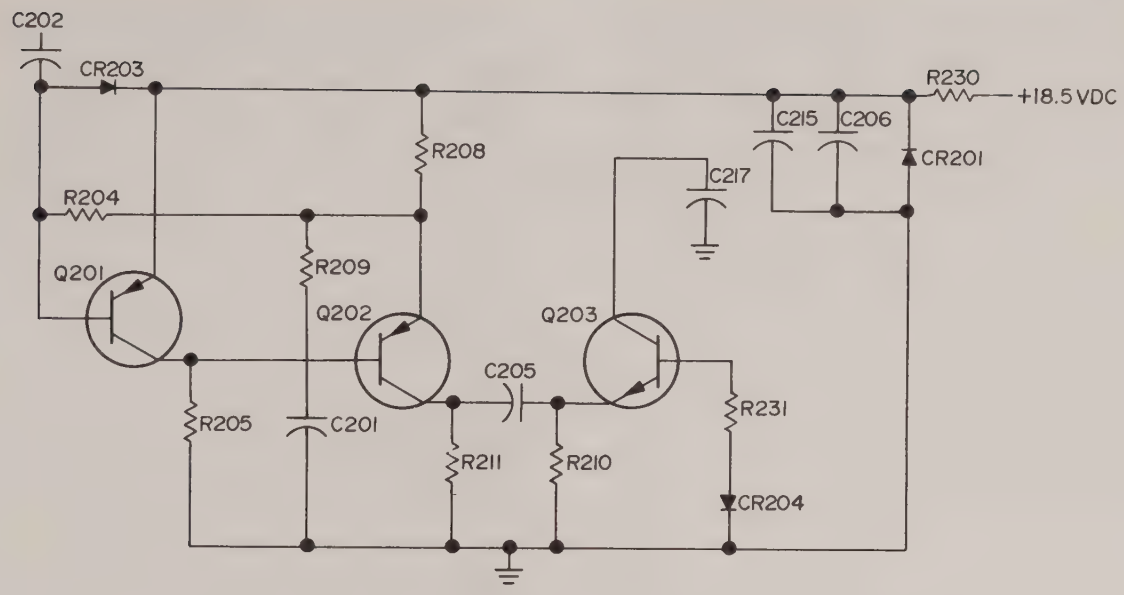


Figure 3-3. Differentiator Amplifier

3-19. Video Amplifier. (See figure 3-4.) The voltage from the range selector circuit is applied to the base of transistor Q104, an emitter-follower. The base circuit of Q104 is an ac voltage divider consisting of R118, C109, and R119. Emitter-follower Q104 provides impedance matching between the range selector voltage divider and the video amplifier.

3-20. The signal from the emitter of transistor Q104 is amplified by transistors Q105 and Q106 and then applied to the peak detector. The video output pulse is also coupled to the VIDEO OUT jack by R152 and C154.

3-21. Dc feedback is applied to the base of transistor Q104 from the emitter of transistor Q106 through R120. Ac feedback is applied to the emitter of Q105 from the collector of Q106 through C113, C111, R124, and R127. Resistor R124 acts as a gain control by adjusting the amount of feedback in the emitter circuit of transistor Q105, thereby varying the current through Q105 and changing the gain of the amplifier.

3-22. Peak Detector. (See figure 4-6.) The output of the video amplifier is coupled through capacitor C1 to the base of transistor Q1. Q1 operates as a gate and remains open as long as the dc analog voltage on the emitter is less than the pulse voltage on the base. Assuming the gate is open, the pulses from the video amplifier pass through transistor Q1 and appear on the base of transistor Q2 as negative spikes. Emitter-follower Q2 passes the negative spikes through diode CR4 to the collector of Q3. Transistors Q3 and Q4 form a monostable multivibrator. The negative spikes trigger the monostable multivibrator to produce positive pulses which are applied through diode CR3 to the base of transistor Q5 and to capacitor C6, charging C6. Emitter-follower Q5 drives a voltage divider composed of R14 and R3. The voltage divider supplies the dc analog output to the meter circuit and also provides feedback to the emitter of gate Q1.

3-23. Gate Q1 remains open as long as the voltage on the emitter is less than the pulse amplitude on the base of Q1. When the voltage on capacitor C6 is such as to cause the dc analog voltage to be the same as the amplitude of the pulses from the video amplifier, the feedback voltage causes the gate to close, preventing further charging of capacitor C6.

3-24. Resistor R103, the METER ZERO control, permits adjustment of the voltage on the base of Q1 with respect to the emitter so that the meter indicates zero with no input applied to the gate. The emitter of transistor Q1 is connected to a negative supply rather than to ground to obtain a sufficient VOLTAGE swing for meter zeroing. Capacitor C3 presents a low impedance path to ground from the emitter of Q1 to prevent degeneration.

3-25. Calibrator. (See figure 4-4.) The calibrator, a ramp generator, provides three different ramp slopes. The ramp slope chosen is based upon the ramp output of barretters with a standard-established 30-milliwatt r-f peak power input when loaded with the 66A3 input impedance. Therefore, the calibrator output represents the ramp output of a specific type of barretter with 30 milliwatts of r-f peak power applied. The three barretter sensitivities are 180, 360, and 720 microvolts per milliwatt per microsecond.

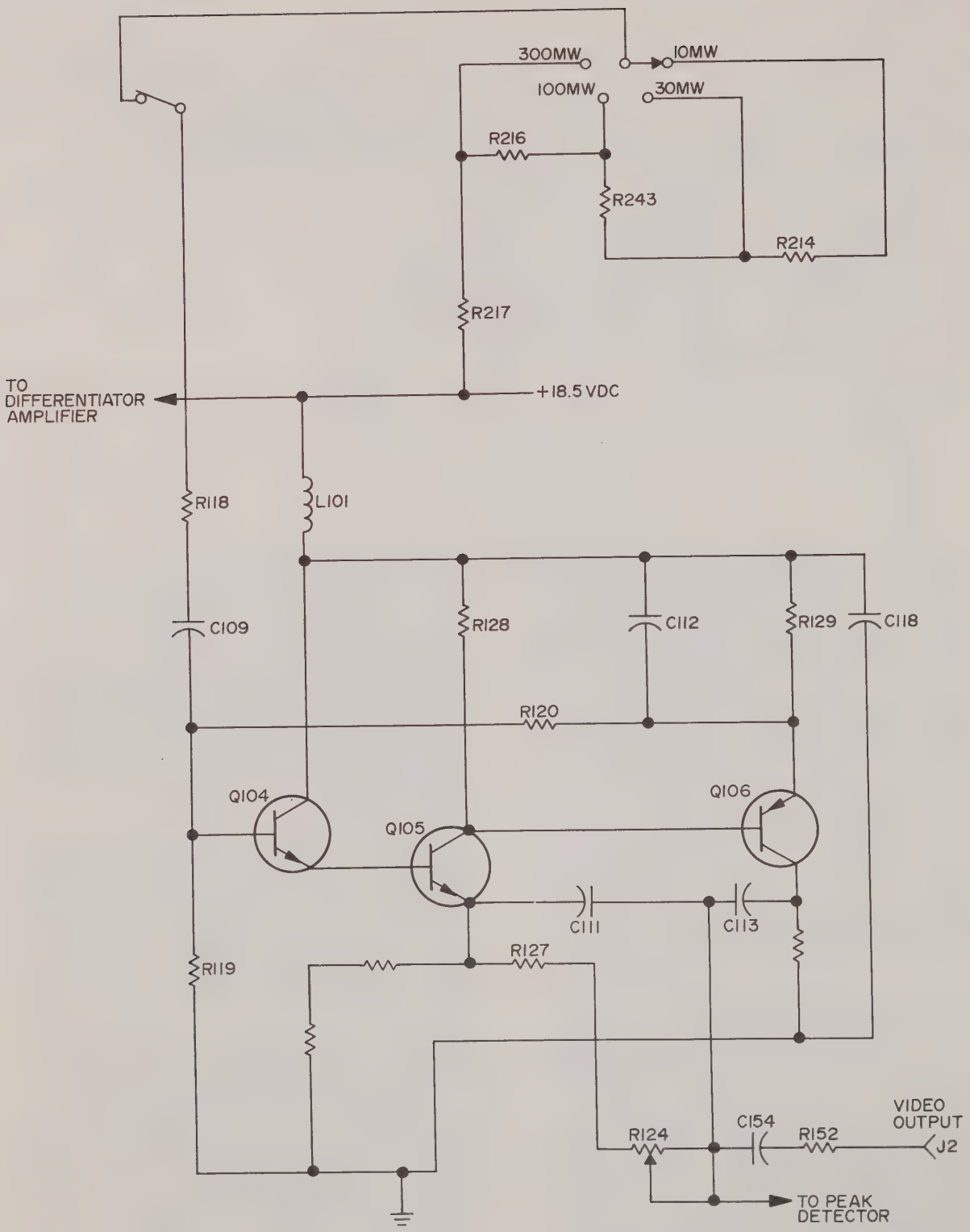


Figure 3-4. Range Selector and Video Amplifier

3-26. The calibrator consists of a pulse oscillator a gate, and a charging network. Transistors Q11 and Q12 form a pulse oscillator operating at approximately 1.5 kc. The oscillator output is applied through differentiating network C14 and R40 to diode CR13. Diode CR13 permits the negative pulses to be applied to the base of the gate, transistor Q13. The gate is normally in conduction and is switched into nonconduction for three microseconds when the negative pulse from the oscillator is applied to the base. When the gate stops conducting, capacitor C105 charges through one of the three networks (R29-R30, R27-R32, R28-R31). After three microseconds the gate again conducts and capacitor C105 discharges through resistor R33, diode CR14, and transistor Q13.

3-27. The slope of the three calibrator ramps is established by the adjustment of the appropriate resistor (R30, R31, or R32). The ramp output is coupled to the differentiator-amplifier, in the calibration function, through switch S2.

3-28. Bolometer Bias Circuit. Bias is applied to the bolometer in all positions of the function switch; however, in the calibrate position, the bolometer is not connected to the power meter circuits. Figure 3-5 is a simplified diagram of the bolometer bias circuit.

3-29. When the BOLOMETER SELECTOR switch is placed in either the P38B1, P38B7 of the P38B3 position, bias is applied to the bolometer through resistor R221, thus providing 8.75 ma bias. When the switch is in the P38B6 position, 4.5 ma bias is applied through R222. Resistors R221 and R222 are adjustable so that when the 66A3A is in the bolometer test function, the bias can be adjusted to the exact value (8.75 or 4.5 ma). Diode CR202, a 10 volt zener and diode CR205, a 6.1 volt zener, are bolometer protective devices which limit the bias voltage to 10 volts and 6.1 volts, respectively.

3-30. Metering and Function Selector Circuits. Figure 3-6 is a simplified diagram of the circuits associated with the three positions of the function switch.

3-31. When the function switch is in the OPER position, the ramp from the bolometer is applied to the differentiator-amplifier. The dc analog voltage from the peak detector is applied to the meter, which operates as a 0-1 ma movement. Bolometer bias is applied to the bolometer through R203, the meter shunt, and R207.

3-32. Meter M1 is basically a 0-1 ma movement. A shunt resistor, contained in the meter case but not connected to the meter movement, is used to extend the meter range to 10 ma when the function switch is in the BOLO TEST position. However, the shunt resistor remains connected in the bolometer bias circuit so that the bolometer bias calibration is not disturbed when operating in other functions.

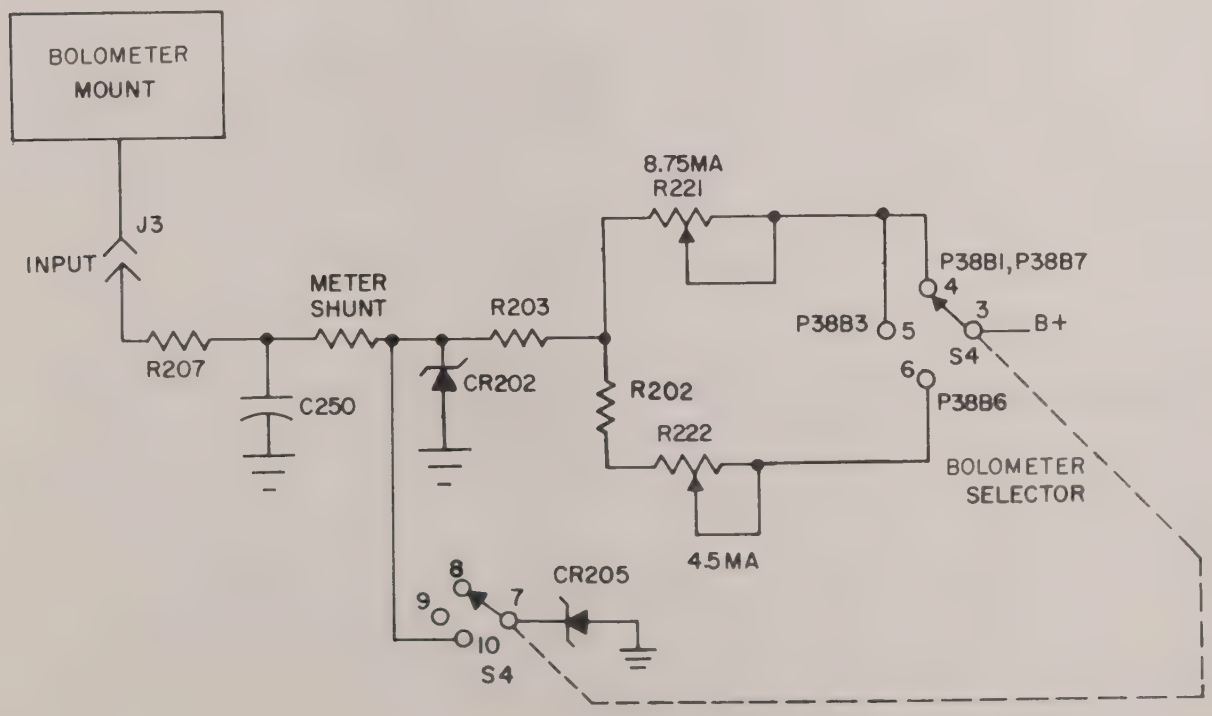


Figure 3-5. Bolometer Bias Circuit

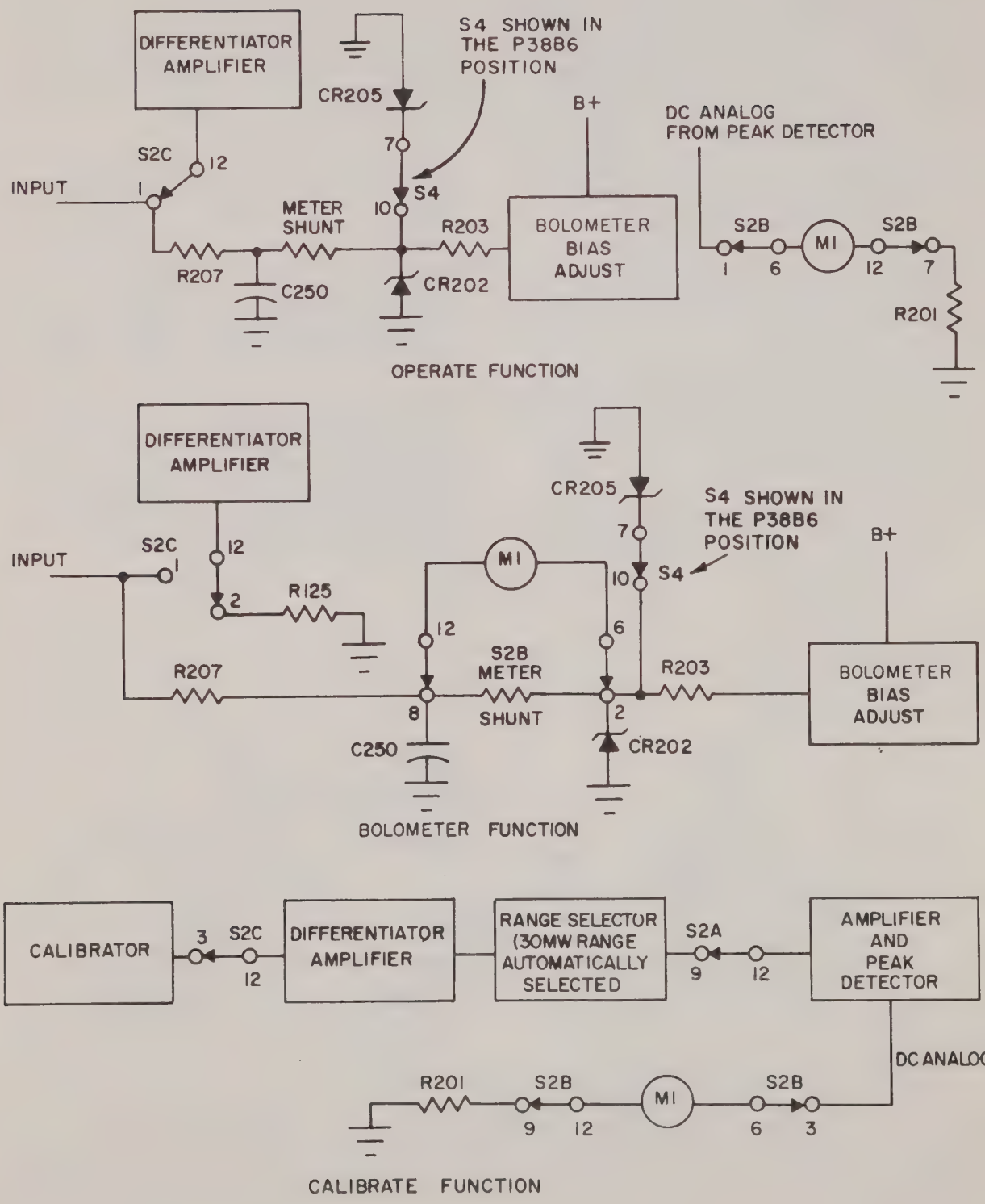


Figure 3-6. Function Switch Circuits

3-33. When the function switch is in the BOLO TEST position, the differentiator-amplifier input is loaded by R125. Bias is applied to the bolometer through the meter and the meter shunt. In this condition, the meter operates as a 0-10 ma movement.

3-34. When the function switch is in the CAL position, the INPUT jack is disconnected from the power measuring circuits and the calibrator output is connected to the differentiator-amplifier input. The range selector circuit is automatically set to the 30 milliwatt range, and the dc analog output of the peak detector is applied to the meter. In this function the meter operates as a 0-1 ma movement and the shunt is connected in the bolometer bias circuit.

3-35. The meter pointer will oscillate slightly due to the small amount of ripple on the dc analog voltage. This is caused by the random charging of capacitor C6 in the peak detector.

3-36. Power Supply. (See figure 4-3.) The power supply consists of a bridge rectifier, a series regulator circuit, and a battery charging circuit. The mode selector switch permits switching from AC to BAT operation or to the charging (CHG) function. The series regulator provides a +18.5 volt supply for operation of the circuits. Diode CR9 provides a -0.75 volt supply for the meter zero circuit.

SECTION IV

MAINTENANCE

4-1. GENERAL

4-2. This section provides servicing information and instructions for performing maintenance checks, troubleshooting, and repair of the Power Meter and the accessory battery and thermistor Mounts.

4-3. PREPARATION FOR MAINTENANCE

4-4. No special procedures are required for setting up the Power Meter preparatory to maintenance; set the unit on the test bench in close proximity to test equipment required for testing and a suitable ac line voltage source of 115 or 230 volts, 50 to 440 cps.

4-5. TEST EQUIPMENT REQUIRED

4-6. Test equipment required for repair, test and/or checkout of the Power Meter is listed in table 4-1. Test equipment with equal or greater range and accuracy than that stated in the Specifications column may be substituted.

4-7. CALIBRATION TEST PROCEDURE

4-8. The Power Meter calibration test procedure verifies satisfactory operation of the unit; it can be used as a minimum performance standard for determining proper operation of a new Power Meter or as an acceptance test following repair.

4-9. Paragraphs 4-10 and 4-11 present detailed preliminary and calibration procedures which should be performed periodically or whenever a faulty component is repaired or replaced in the Power Meter.

4-10. Preliminary Procedure. The calibration procedure also provides a complete power supply check. Refer to figures 4-1 and 4-2 for location of adjustments. During the procedure, observe the following precautions:

a. Do not adjust any control unless it is specifically called for. Failure to observe this precaution may result in inaccurate power measurements.

b. Do not connect a bolometer to the INPUT jack. R-f power is not required for calibrating the peak power meter.

c. If any of the specified requirements or conditions given in the procedure cannot be achieved, discontinue the calibration sequence and refer to table 4-2, Troubleshooting Chart.

d. Remove the cover of the 66A3A to gain access to the internal calibration controls.

e. Make all measurements with respect to chassis ground.

f. When setting the mechanical zero adjustment, use the mirror on the meter scale to eliminate parallax and to increase the accuracy of the zero setting.

4-11. Calibration Procedure. Perform the calibration procedure as follows:

a. With the 66A3A in its normal operating position and turned off for at least a minute, rotate the mechanical zero-setting screw until the panel meter pointer is directly over the zero calibration line on the scale. Then turn the zero-set screw in opposite direction approximately 15 degrees. This assures that the zero-set screw does not contact the meter movement. If meter pointer movement is observed during the 15 degree rotation, rezeroing is necessary.

b. Connect ac power cord to an ac supply and set Power Selector Switch to AC.

Table 4-1. Test Equipment Required for Maintenance

Test Equipment	Purpose	Specifications	Manufacturer
Electronic Multimeter	Measure dc voltage.	1, 3, 10, and 30 vdc, 3% accuracy	Hewlett-Packard HP 410B
Oscilloscope	Analyze video waveshape.	Manufacturer's specs	Tektronix 531
Variable transformer	Vary line voltage to check power supply regulation.	Voltage range: 100 to 130, 207 to 253 volts Current: 1 amp	General Radio W5MT3A

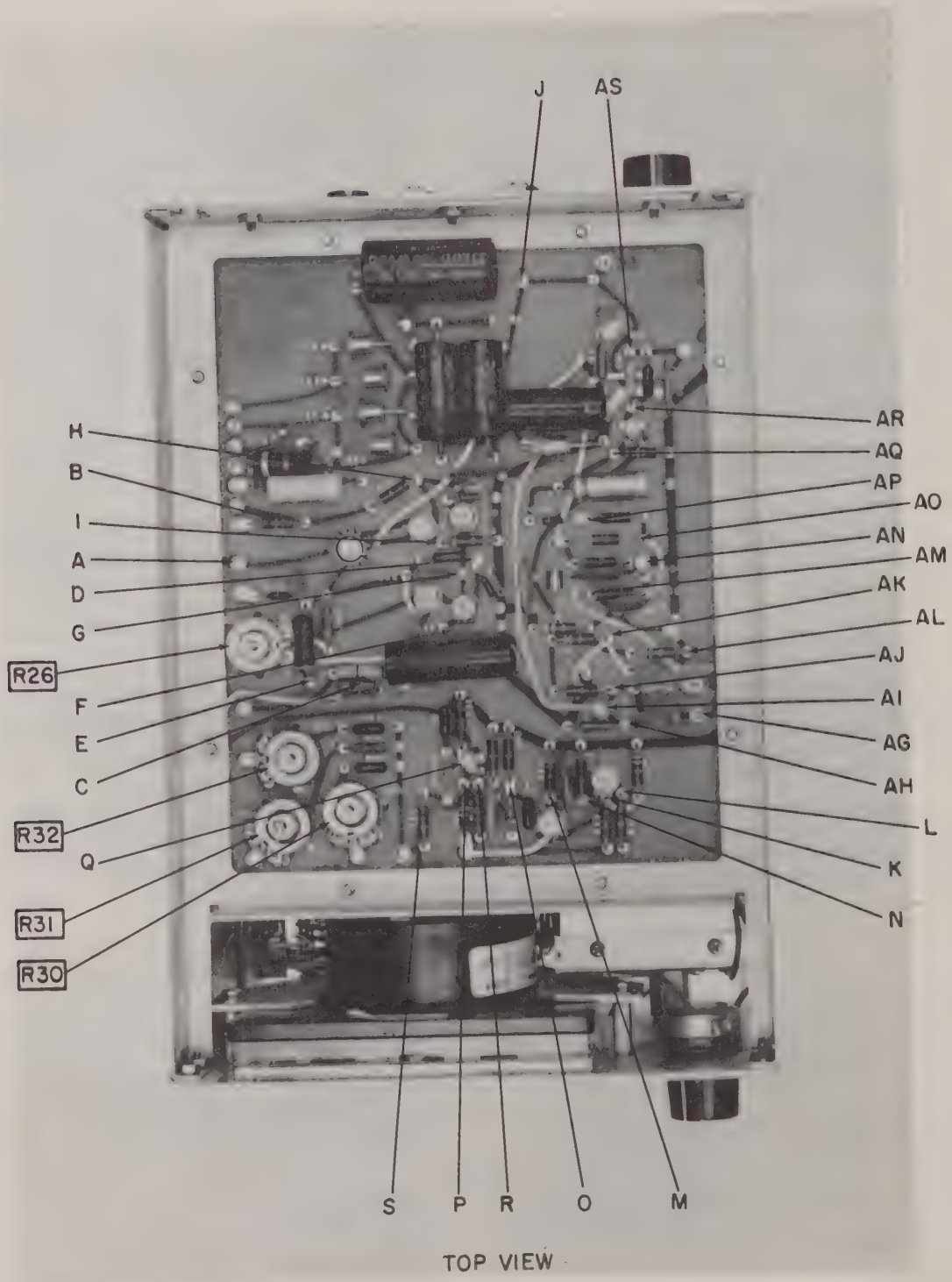


Figure 4-1. Main Component Board, Top View

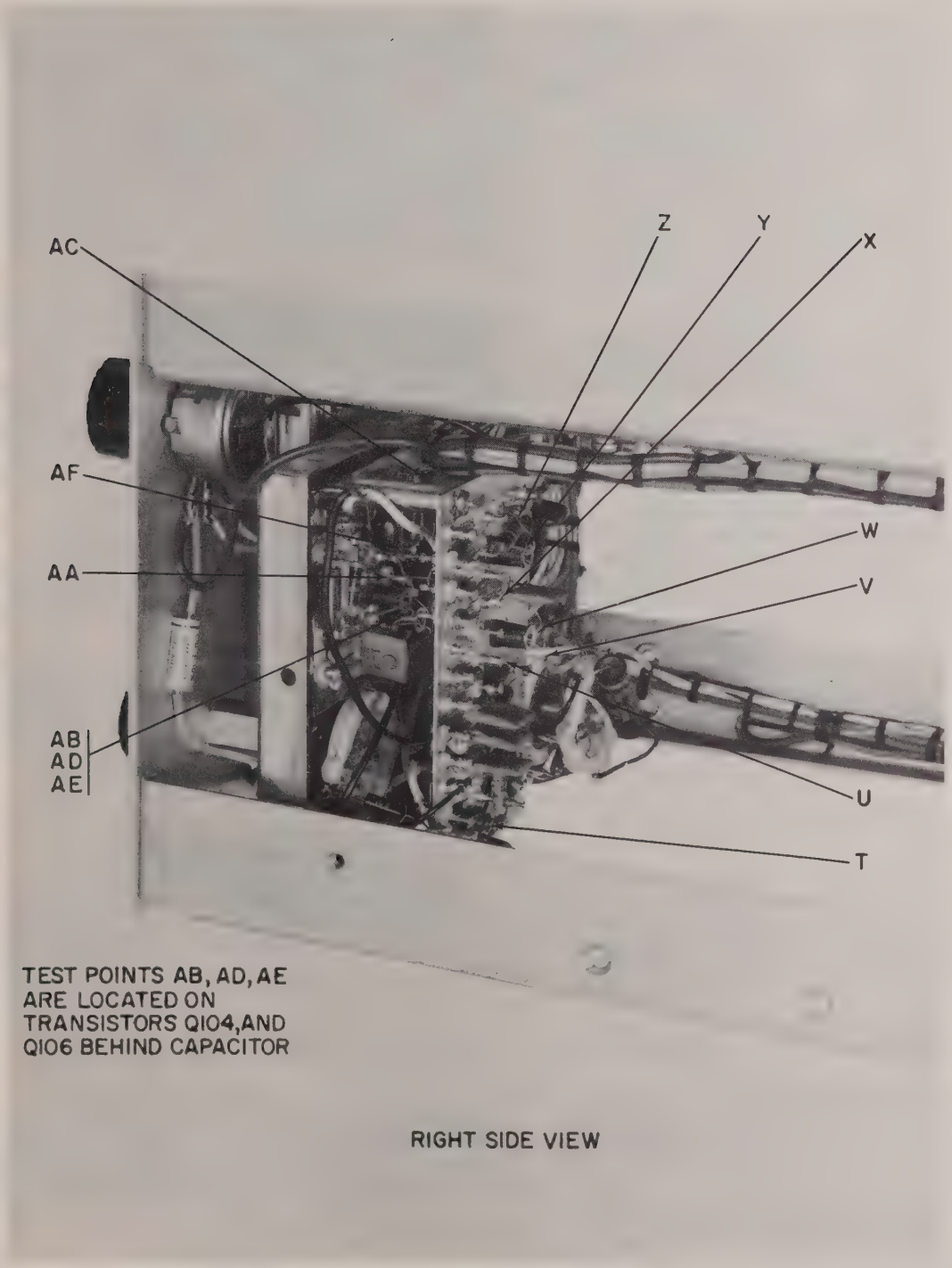


Figure 4-2. Video Circuit Component Board

c. Connect VTVM to terminal E18 and adjust R26 for +18.5 volt indication.

d. Disconnect peak power meter from ac source and connect to variac. Vary ac line voltage from 103.5 to 126.5 (207 to 253) volts and observe voltage at terminal E18. No detectable change should be observed on VTVM.

e. Disconnect peak power meter from variac and connect to normal ac supply. Measure voltage at terminal E18 and adjust R26 if necessary to obtain +18.5 volts.

f. Connect VTVM to terminal E6. Meter should indicate -0.75 volt.

g. If an internal battery is installed, set mode switch to BAT and measure voltage at terminal E15. If meter indication is less than 22 volts, recharge battery.

h. Set Power Selector Switch to AC, Function Selector switch to OPER, and Range Selector switch to 300 mw. Do not connect a bolometer. Adjust METER ZERO control on rear panel for zero indication on the meter, if necessary.

i. Set Function Selector Switch to CAL and BOLOMETER SELECTOR switch to P38B6. Connect one end of 2-foot (maximum) length of RG-58/U cable to oscilloscope. Connect center conductor of other end to terminal E22 and connect shield to chassis.

j. Observe the ramp on oscilloscope and adjust R31 for a ramp of 18 millivolts per microsecond rise. The waveshape of test point S in table 4-2 is the same. The slope measurement must be made in the first 1.5 microseconds of the ramp, preferably as close to the start as possible.

k. Remove oscilloscope. Adjust CAL ADJ control for a full scale deflection on meter.

l. Set BOLOMETER SELECTOR switch to P38B3. Adjust R32 for exactly half-scale deflection.

m. Set BOLOMETER SELECTOR switch to P38B3. Adjust CAL ADJ control for full scale deflection on meter.

n. Set BOLOMETER SELECTOR switch to P38B1 and P38B7. Adjust R30 for exactly half-scale deflection.

o. Set BOLOMETER SELECTOR switch to P38B3. Connect oscilloscope to VIDEO OUT jack.

p. Adjust CAL ADJ control for full scale deflection. Pulse displayed on oscilloscope should be approximately 3 microseconds wide and have an amplitude of approximately 1.6 volts peak. Disconnect oscilloscope.

q. Connect VTVM across R201 (1500 ohm resistor across RECORDER jack). VTVM should indicate 1.5 volts.

r. Place Function Selector Switch at BOLO TEST and connect a 200 ohm ±1% resistor from center conductor of INPUT jack to chassis ground. Adjust 8.75 MA BIAS ADJ control on rear panel for 8.75 ma indication on meter.

s. Set BOLOMETER SELECTOR switch to P38B6 and adjust 4.5 MA BIAS ADJ control for 4.5 ma indication on meter scale. Remove 200 ohm resistor.

t. Set Power Selector Switch to OFF, disconnect all test equipment, and replace cover. The peak power meter is calibrated and ready for operation. Always perform Operational Adjustments, Section II, before measuring power.

4-12 TROUBLESHOOTING TEST PROCEDURES

4-13. When there is an indication of trouble in the Power Meter, the bolometer Mount and cable in use should first be checked to isolate the malfunction to the Power Meter. Check the Mount, using the operating information supplied with the Mount. If the Mount in use is defective, replace it with a known good Mount and return the Power Meter to use. Check the continuity of the bolometer Mount cable conductors and examine the cable connectors. Repair or replace the cable if found defective. Mount bolometer replacement data is presented in paragraph 4-34.

4-14. Trouble in the Power Meter is reflected by lack of, or improper, panel meter indications. Table 4-2 presents a malfunction troubleshooting chart which indicates meter symptoms and the probable cause of the erroneous display. If it becomes necessary to replace components in the Power Meter refer to repair and replacement instructions, paragraph 4-28, for the proper procedures.

4-15. The Power Meter troubleshooting chart, Table 4-2, will aid in the isolation of faulty components. Refer to figures 4-1 and 4-2 for location of test points and schematic diagrams, figures 4-5 through 4-6.

4-16. All waveforms and voltages are with respect to ground and without a Bolometer Mount connected to the input jack. Follow each step in chart in the given sequence until trouble is isolated. Replace defective components and recalibrate the Power Meter.

4-17. Set Power Meter controls as follows:

a. Power Selector Switch to AC position.
b. Range Selector Switch to 300 mw position.
c. Function Selector Switch to OPER position.
d. CAL ADJ control - set after step j of table 4-2.
e. BOLOMETER SELECTOR Switch to P38B3 position.
f. METER ZERO control for electrical zero.

4-18. FUNCTIONAL TESTS

4-19. Functional tests for the Power Meter power supply and accessory battery are presented in paragraphs 4-20 through 4-23, and should be used to aid in the determination of the malfunctioning section of the Power Meter power supply.

NOTE

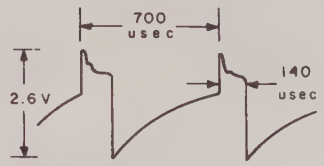
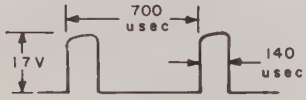
Perform these tests without any Bolometer Mount connected to the input jack.

Table 4-2. Power Meter Troubleshooting Chart

* Test Point	Waveform Data	Voltage (Dc)	Probable Malfunction
A	———	+22 v min	Discharged battery or defective ac supply
B	———	+22 v min	Battery (BATT mode) CR11 or R19 (AC mode)
C	———	+18.5 v	Adjustable with R26. Note If +18.5 v is obtained, power supply is not malfunctioning. Delete checks for test points D through I. When voltage at test point C is zero, Q9 is open or C12 is shorted. When voltage is high and can't be adjusted with R26, check test point D.
D	———	+5.9 v	CR12 Note If test point D is +5.9 v, substitute a variable 0 to 30 vdc power supply for battery. Adjust power supply for 18.5 vdc at test point C and proceed with checks at test point E.
E	———	+5.85 v	Q7 C11 R24 R26 R25
F	———	+5.3 v	Q7 Q6 R23 R22

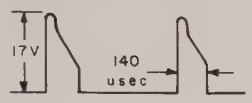
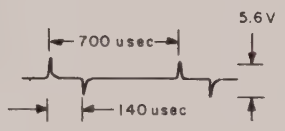
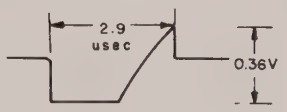
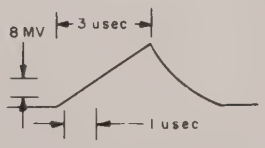
*See photographs, Figures 4-1 and 4-2, and schematic diagrams, Figures 4-3 through 4-6.

Table 4-2. Power Meter Troubleshooting Chart (Cont)

* Test Point	Waveform Data	Voltage (Dc)	Probable Malfunction
G	———	+11.8 v	Q10 CR10
H	———	+20.1 v	Q10 CR10 Q8 R20 C18
I	———	+19.5 v	Q8 Q9 R18
J	———	-.75 v	CR9 or C10
	Run balance of tests with Power Selector Switch set to AC; Function Selector switch set to CAL, after 66A3A has been zeroed in OPER position; BOLOMETER SELECTOR switch set to P38B3 without a BOLOMETER connected to 66A3A; and CAL ADJ control set for meter full scale reading.		
K	 * See note	+1.8 v	Q11 R35 R36
L		+4.3 v	Q11 Q12 R37 C14
M		+7.2 v	Q12 R39 C13

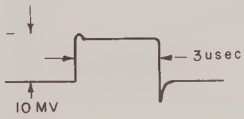
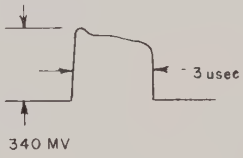
*See photographs, Figures 4-1 and 4-2, and schematic diagrams, Figures 4-3 through 4-6.

Table 4-2. Power Meter Troubleshooting Chart (Cont)

* Test Point	Waveform Data	Voltage (Dc)	Probable Malfunction
N		+2.1v	Q11 R38 C13
O		Ov	C14 R40 CR13
P		+0.96v	Q13 C15 CR13 R42 R41
Q		+0.26v	Q13 R34 R43
R		+0.44v	Q13 C16 CR14
S	 Rate or rise of ramp is 8.0 mv per 1 usec over a 3 usec period.	+1.15v	R32 R27 CR14 R33 C105 R112 Q201

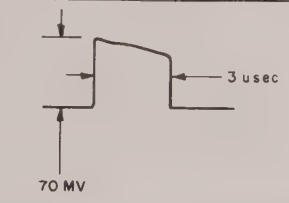
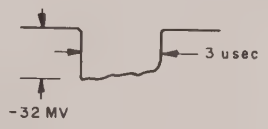
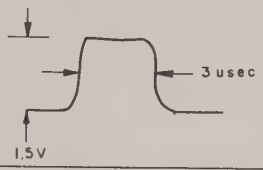
*See photographs, Figures 4-1 and 4-2, and schematic diagrams, Figures 4-3 through 4-6.

Table 4-2. Power Meter Troubleshooting Chart (Cont)

*Test Point	Waveform Data	Voltage (Dc)	Probable Malfunction
T	Signal is to low to be measured	+6.5 v	Q201 R204 CR203
U		+6.2 v	Q201 Q202 R205
V		+6.4 v	Q202 R208 R209 R204
W		+2 v	R211 C205
X	Same as test point W	+1.01	C205 Q203 R210
Y		+1.5 v	CR204 R231 R213
Z		+3.5 v	Q203 C217

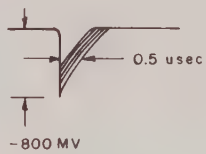
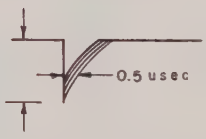
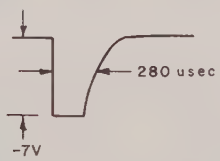
*See photographs, Figures 4-1 and 4-2, and schematic diagrams, Figures 4-3 through 4-6.

Table 4-2. Power Meter Troubleshooting Chart (Cont)

* Test Point	Waveform Data	Voltage (Dc)	Probable Malfunction
AA		+5.2 v	Q104 C109 R119 R118 R215 R216 R217 R214
AB	Same as test point AA	+4.6 v	Q104 Q105
AC		+10.5 v	Q105 Q106 R128
AD		+11 v	Q106 R129 C112 R120
AE		+4.1 v	Q106 R123 C113
AF	Same as test point AA	+3.9 v	Q105 C113 C111 R124 R127
AG	Same as test point AE	+3.9 v	C113 C1

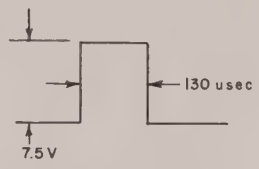
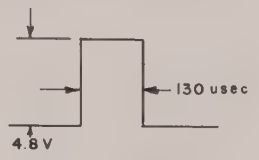
*See photographs, Figures 4-1 and 4-2, and schematic diagrams, Figures 4-3 through 4-6.

Table 4-2. Power Meter Troubleshooting Chart (Cont)

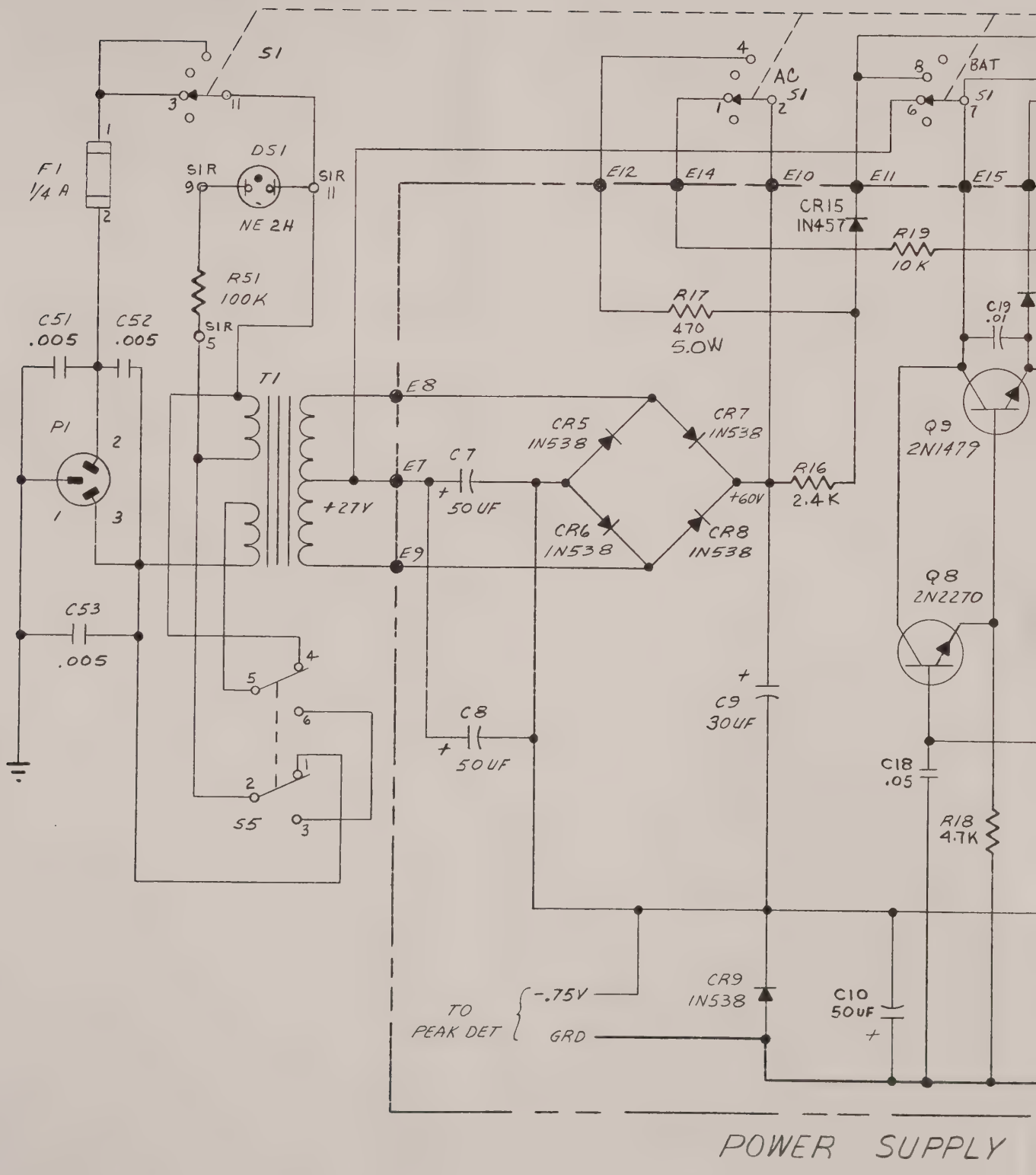
* Test Point	Waveform Data	Voltage (Dc)	Probable Malfunction
AH	Same as test point AE	+.64 v	Q1 C1 R15 R4
A1		+1.5 v (Feedback from Q5)	Q1 R3 R14 Q5
AJ		+7.2 v	Q1 Q2 R5
AK		+7.2 v	Q2 R6 CR4
AL		+7.2 v	CR4 Q3/Q4 Circuit
AM		+.09 v	Q3/Q4 Circuit
AN		+.78 v	Q3/Q4 Circuit

*See photographs, Figures 4-1 and 4-2, and schematic diagrams, Figures 4-3 through 4-6.

Table 4-2. Power Meter Troubleshooting Chart (Cont)

* Test Point	Waveform Data	Voltage (Dc)	Probable Malfunction
AO		+.28 v	Q3/Q4 Circuit CR3 Q5 C6 R13
AP		———	R12 CR3 Q5 R13 C6
AQ	———	+4.0 v	CR3 C6 R13 Q5
AR	———	+3.3 v	Q5 R14 R3
AS	———	+1.5 v	R14 R3
	* Note: Time duration of wave forms may vary slightly from unit to unit because of component tolerances.		

*See photographs, Figures 4-1 and 4-2, and schematic diagrams, Figures 4-3 through 4-6.



POWER SUPPLY

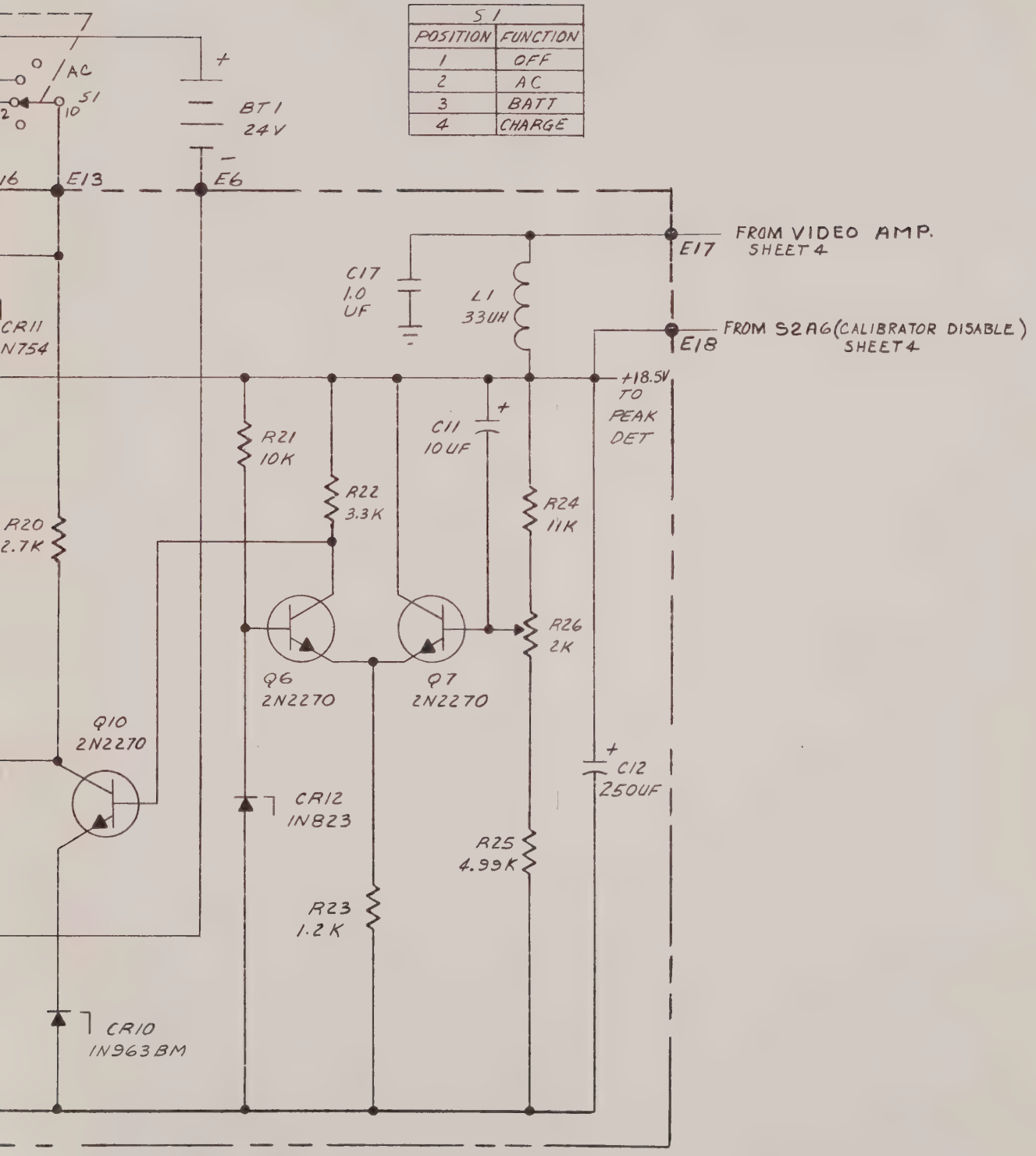
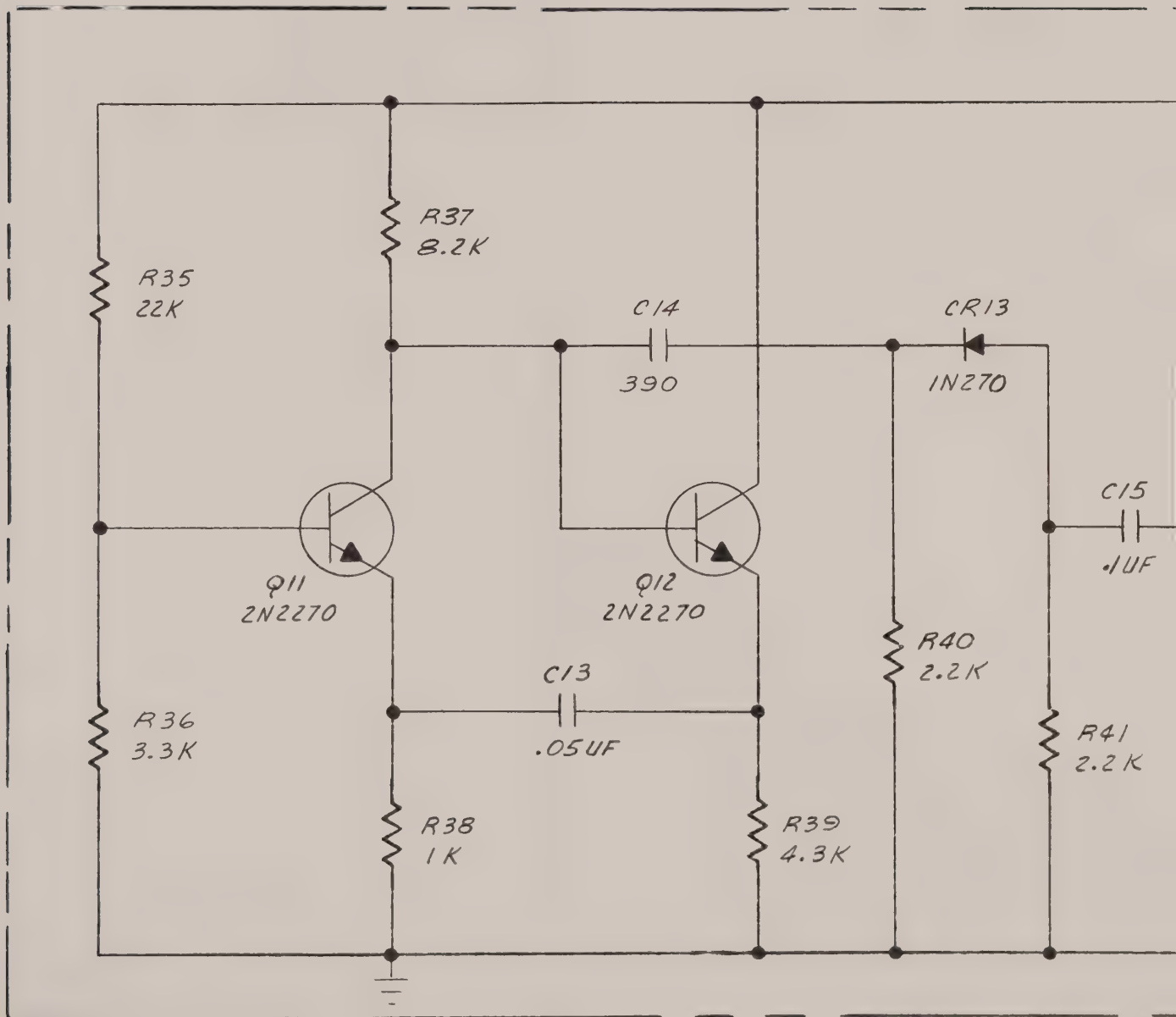


Figure 4-3. Power Supply Schematic Diagram


R37
8.2K
R35
22K
C14
390
CR13
IN270
C15
.1UF
Q11
2N2270
Q12
2N2270
R40
2.2K
C13
.05UF
R36
3.3K
R41
2.2K
R38
1K
R39
4.3K

CALIBRATOR

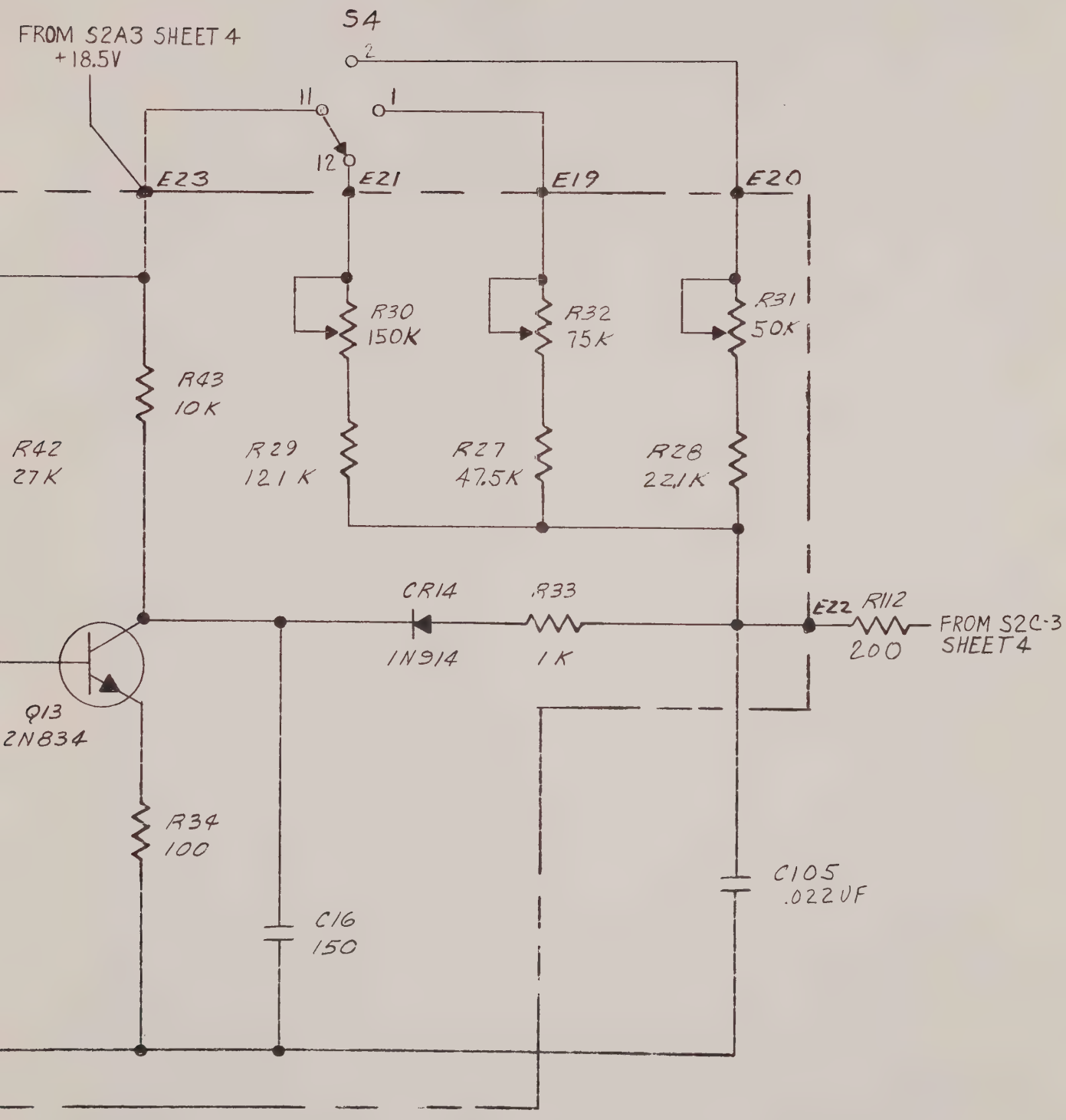
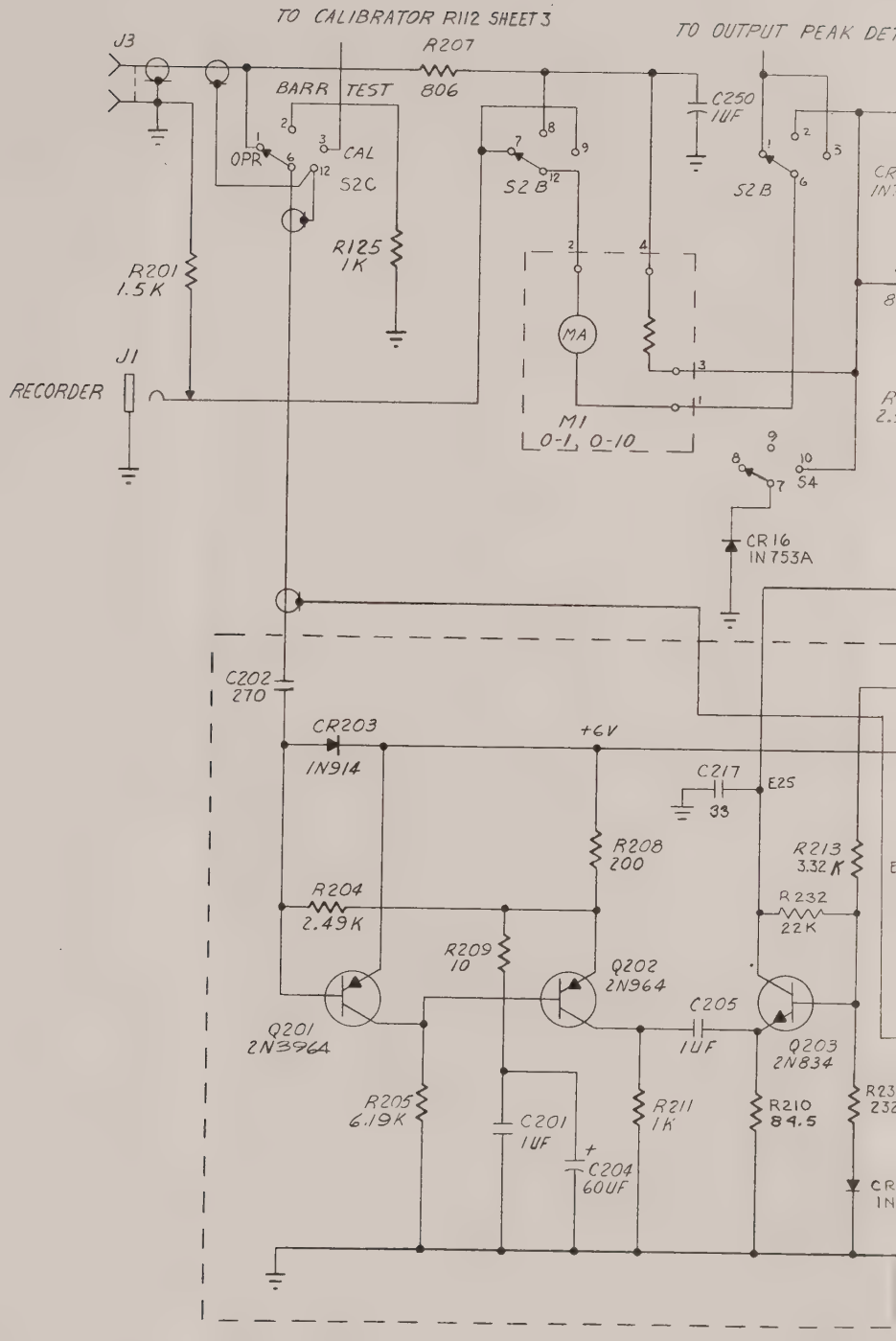
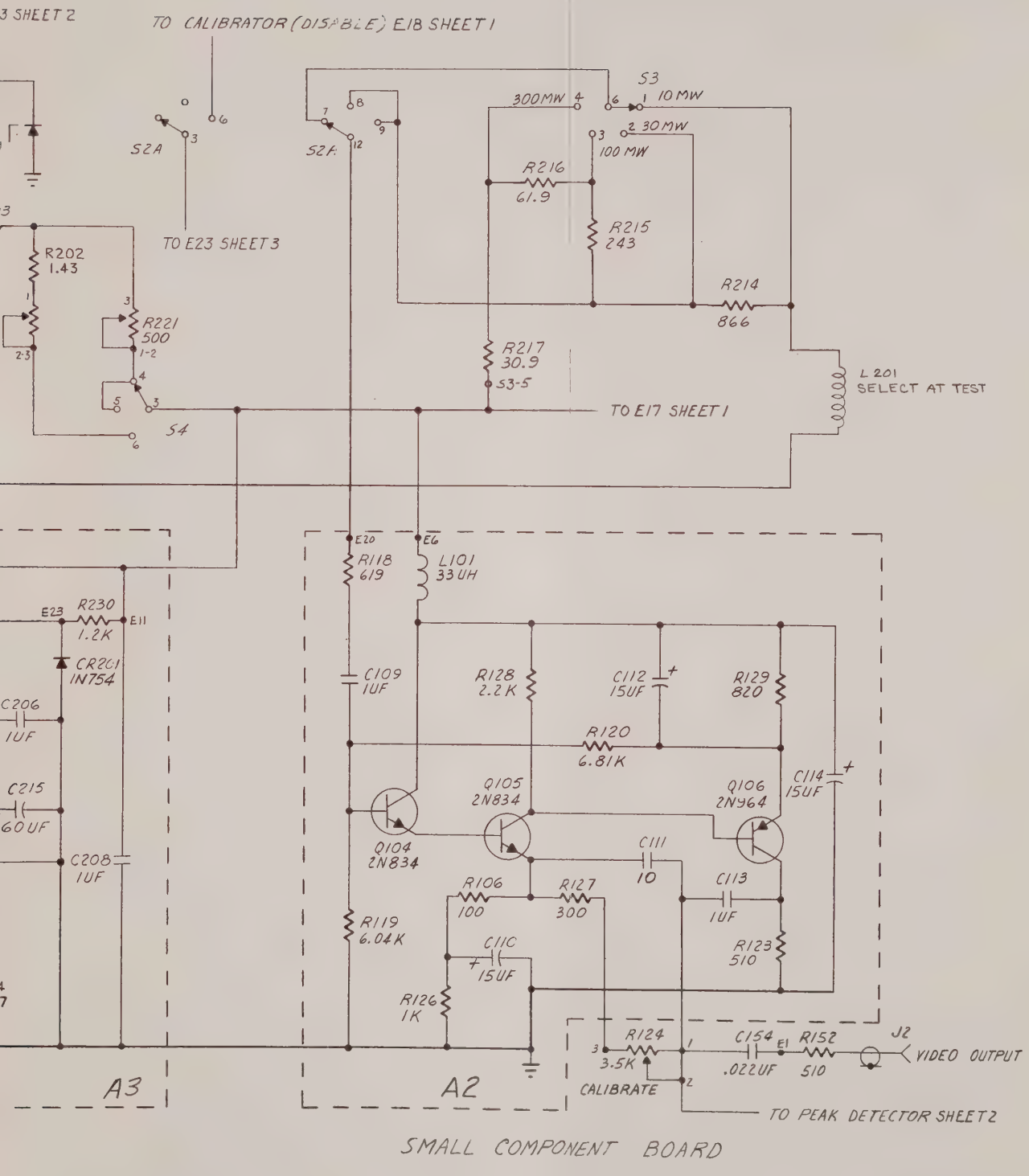


Figure 4-4. Calibrator Schematic Diagram



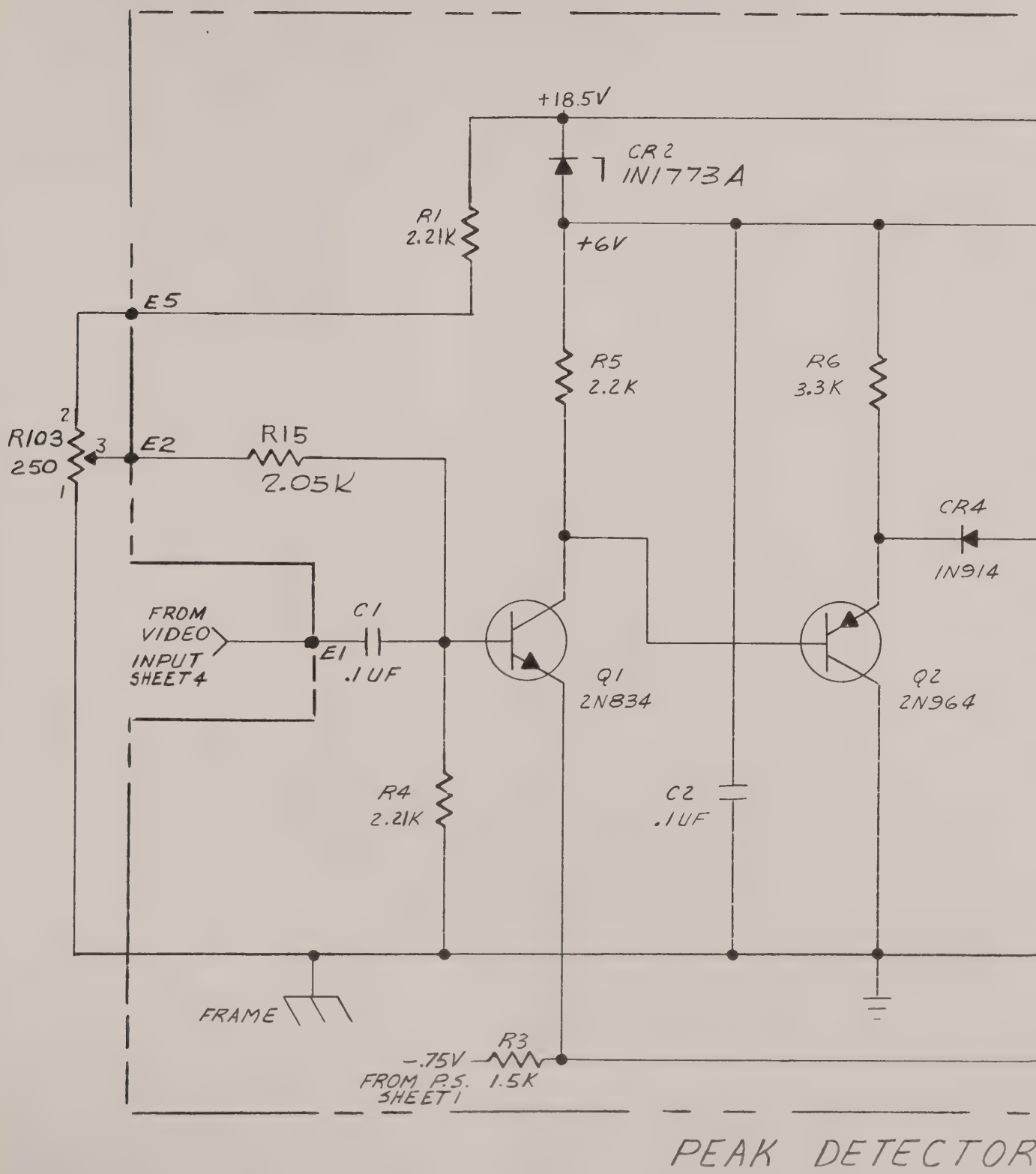
NOTE -

PWR SUPPLY MUST BE
SET TO 18.5 VOLTS



VIDEO AMPLIFIER

Figure 4-5. Video Amplifier Schematic Diagram



PEAK DETECTOR

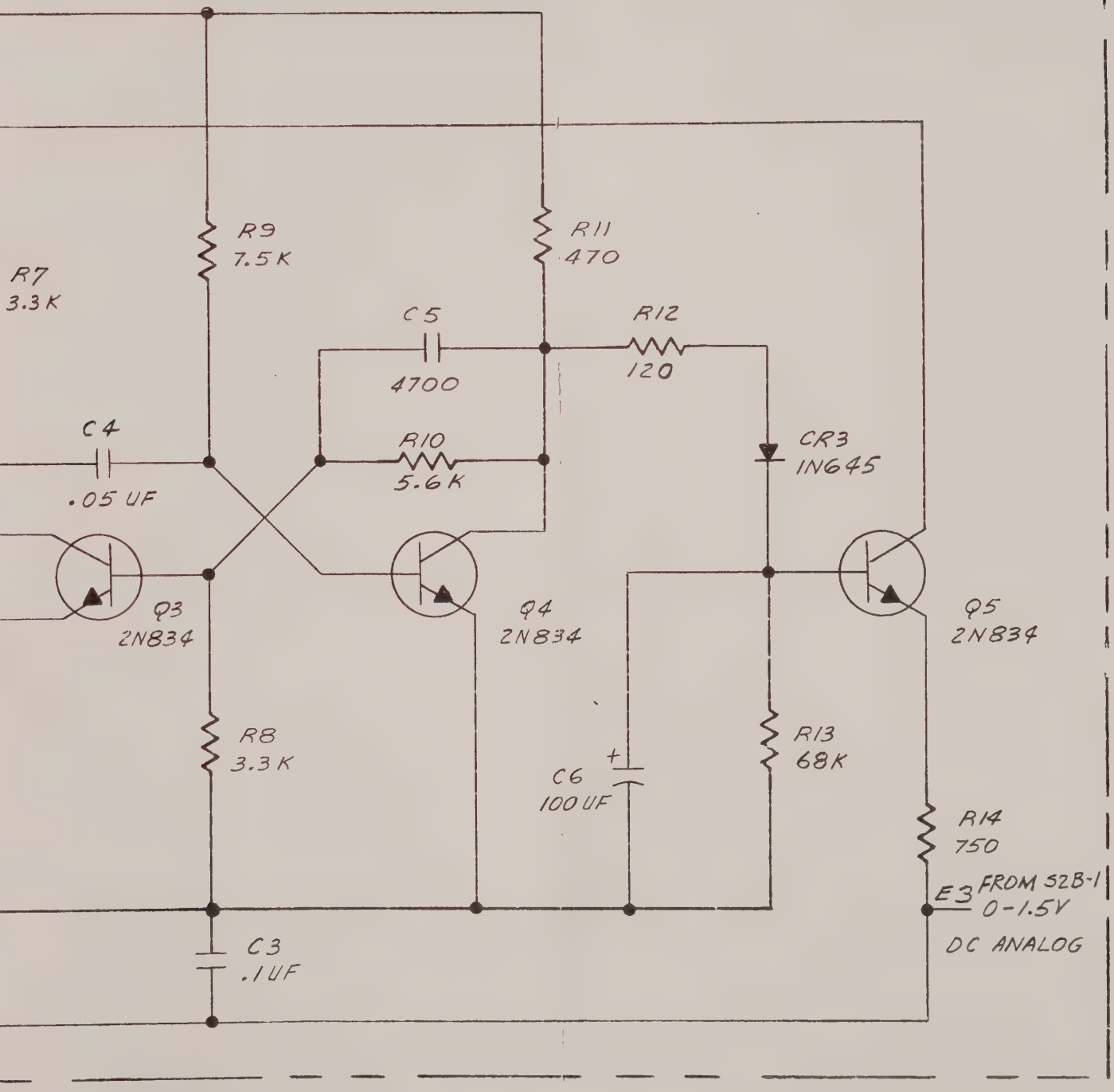


Figure 4-6. Peak Detector Schematic Diagram

4-20. POWER SUPPLY TESTS. Perform the power supply test as follows:

a. Connect ac line cord to ac primary source and set Power Selector Switch to AC.

b. Connect dc voltmeter to terminal E18 and Power Meter ground.

c. Energize Power Meter following applicable turn-on procedure, and note voltmeter reading. Voltage should be +18.5 vdc. If not, adjust output voltage according to power supply adjustment procedure, paragraph 4-27.

d. If normal +18.5 vdc cannot be obtained through adjustment, or if the regulation test outlined in step e. does not produce satisfactory results, connect the dc voltmeter between test points listed in the Test Point column of table 4-2 and Power Meter ground. If dc voltages are not within specified limits at any of these test points, check components listed in table 4-2. Replace parts found to be marginal or defective. Voltages at these test points are applicable for both ac and battery power.

e. Disconnect Power Meter from ac source and connect to variac. Vary ac line voltage from 103.5 to 126.5 (207 to 253) volts and observe voltage at terminal E18. There should not be any noticeable change in +18.5 vdc indication on voltmeter.

f. Disconnect Power Meter from variac and connect to normal ac source.

g. Connect dc voltmeter to terminal E6 and note voltmeter indication. Voltage should be -0.75 volt.

4-21. BATTERY TESTS. Installation and use instructions for the accessory nickel-cadmium battery are provided in Section II of this manual. After any extensive storage period, the battery should be fully recharged prior to use. The battery cells are sealed and do not require the addition of any liquid.

4-22. Battery Voltage and Current Test. A milliammeter, a dc voltmeter, a 7500-ohm, 2-watt resistor, and a 780-ohm, 3-watt resistor are needed for testing the battery. Disconnect the ac power line and proceed as follows to test the battery:

a. Attach dc voltmeter between terminal E15 on circuit board assembly and Power Meter ground. Set power selector switch to BAT position; battery voltage, observed on the dc voltmeter, should be +22 vdc minimum.

b. Set power selector switch to OFF position; disconnect lead from either B+ or B- terminal of circuit board assembly.

c. Connect milliammeter in series with disconnected lead and circuit board terminal from which lead was removed.

d. Set the power selector switch to BAT and observe current drain. The milliammeter indication should be between 40 and 53 ma.

e. On completion of test, reconnect removed lead.

4-23. Battery Charging Circuit Test. Proceed as follows to test the battery charging circuit of the Power Meter:

a. Set power selector switch to OFF. Connect Power Meter to ac line; disconnect both leads of battery from circuit board assembly.

b. Connect 780-ohm resistor in series with milliammeter, and attach resistor and meter across battery terminals on circuit board assembly.

c. Set power selector switch to CHG position. Measure charging current regularly supplied to battery. Meter indication should be between 32 and 40 ma. Set power selector switch to OFF position.

d. Remove 780-ohm resistor and connect 7500-ohm resistor in series with milliammeter; connect meter and resistor across circuit board battery terminals.

e. Set power selector switch to AC position and measure trickle charging current regularly supplied to battery. Meter indication should be between 3.2 and 4.8 ma. Reconnect battery leads to proper terminals on circuit board assembly.

4-24. ALIGNMENTS AND ADJUSTMENTS

4-25. Alignments and adjustments for the Power Meter are presented in paragraphs 4-26 and 4-27. If any adjustments cannot be satisfactorily performed, or fail to provide the specified results, refer to the Power Meter troubleshooting procedures, paragraph 4-12 and the troubleshooting chart, table 4-2.

4-26. MECHANICAL ZERO-SETTING OF METER. Proceed as follows to mechanically zero-set the panel meter for best calibration accuracy and mechanical stability.

NOTE

The meter is properly zero-set if the pointer is resting over the zero calibration mark on the meter scale when the Power Meter is at normal operating temperature, resting in normal operating position, and turned off. When setting the mechanical zero adjustment, use the mirror on the meter scale to eliminate parallax and increase accuracy of the zero setting.

a. Follow operating instructions as outlined in Section II (ac operation), and allow Power Meter to remain in operation for a minimum of 20 minutes. This warm-up period will allow panel meter movement to reach normal operating temperature.

b. Turn power selector switch to OFF position, removing power. Allow at least 30 seconds for capacitors to discharge before proceeding.

c. Rotate mechanical zero-setting screw under meter in clockwise direction until meter pointer approaches zero as it moves upscale. Set pointer directly over zero-calibration line on meter scale.

d. Turn zero-set screw in the counterclockwise direction for approximately 15° to make certain that screw does not contact any part of meter movement. Observe any pointer movement.

e. If any meter pointer movement is observed in step d., repeat steps c. and d.

4-27. POWER SUPPLY ADJUSTMENT. (See figures 4-1 and 4-2.) The output level of the +18.5 vdc

regulated supply is initially set at the factory, and normally does not require readjustment unless transistor or other component replacement has been made in this circuit. Proceed as follows to adjust +18.5 vdc supply output potentiometer R26:

a. Connect a dc voltmeter between terminal E18 and Power Meter ground.

b. Set voltmeter for positive readings on proper scale. Adjust potentiometer R26 for a +18.5 vdc indication on voltmeter.

c. Vary line voltage through range from 103 to 127 vac (or 207 through 253 vac). There should not be any noticeable variance in +18.5 vdc voltmeter reading.

4-28. REPAIR AND REPLACEMENT OF COMPONENTS

4-29. The procedures presented herein are intended to aid in the repair and replacement of components for the Power Meter and the Narda Microline Models 33B3 and Bolometer Mounts.

4-30. POWER METER COVER REMOVAL. The following procedures provide instructions for removing the Power Meter from the shielded RFI cover.

4-31. Removing Shielded Cover. Routine checks and adjustments can be performed after removal of the top cover. Proceed as follows:

a. Place Power Meter right-side-up on clean flat surface.

b. Remove three screws located under bezel at rear of cover.

c. Place Power Meter in inverted position on clean flat surface.

d. Remove two self tapping screws on bottom of cover close to front panel.

e. Carefully slide panel chassis assembly out through rear of cabinet.

f. When replacing Power Meter Cover, care must b be taken to ensure that RF gaskets are not damaged. The front panel must be compressed sufficiently to the RF gasket retained by the cabinet housing.

4-32. REPAIRING THE POWER METER. As with any transistorized instrument, soldering irons for repair work must be selected to avoid application of excessive stray voltage or power line leakage to the circuit. Failure to observe this precaution may result in damage to semiconductor components on the board.

CAUTION

Use a heat sink when replacing transistors to avoid damage to the transistor during soldering.

4-33. Use the following procedure to remove and replace component parts on the circuit board assembly. Do not apply excessive heat to the circuit board.

a. Clip defective component leads near component and remove it from board assembly.

b. Apply heat and detach lead with a straight upward motion.

c. To remove components having several connections, melt solder at each connection and keep it molten while working component from board.

d. When mounting the new component on board, take care to clear hole in board and conductor for component lead before inserting lead into hole. Avoid pressure on plated conductor which might tend to separate it from board.

4-34. MOUNT BOLOMETER REPLACEMENT. Bolometer replacement procedures for the Models 3363 and 33( )2 Series Mounts are presented in paragraph 4-35 and 4-36, respectively.

4-35. Replacing Bolometers in 33B3 Mount. (See figure 4-7.) Replace bolometer elements as follows:

a. Holding unit at part A rotate part C counterclockwise and remove.

b. Holding the unit at part B, in the position shown, rotate part A counterclockwise and remove. Observe part D through hole in part A while accomplishing this operation. Part D should not move.

c. Loosen setscrew on part B and remove part B.

d. Lift off part D.

e. Remove part E.

f. Replace part E, making certain the bolometer disc is located on the pins.

g. Reassemble in reverse order.

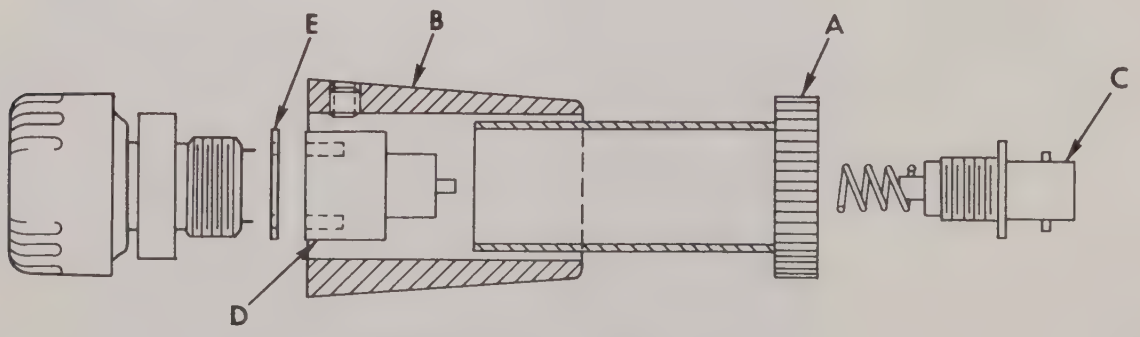


Figure 4-7. Model 33B3 Mount, Bolometer Replacement

4-36. Replacing Bolometers in 33( )2 Series Mounts. (See figure 4-8.) Replace bolometer elements as follows:

a. Models 33S2 (Ser. 101-)°, 33C2, 33G2, 33H2, 33X2.

(1) Loosen setscrew (E).
(2) The BNC connector and spring assembly (A) is unscrewed and removed from the mount. This will normally also remove the trap assembly (B), bolometer element (C), and (D), the lower mounting post.
(3) The lower mounting post (D) and trap section (B) are now unscrewed from the bolometer and disassembly is complete.
(4) Reverse this order for assembly.
NOTE: If removal of the BNC connector spring assembly fails to remove the remainder of the parts, these parts may be removed by pushing on the lower mounting post (D) with the wrench used to loosen the setscrew (E).

NOTE

When reassembling be certain that the lower mounting post (D) has started into the lower aligning hole (in the setscrew (E) area) before tightening the BNC connector.

b. 33S2 (Ser. 1-100) Barretter Mount. In this mount the BNC-trap assembly (A and B) is integral, and secured to the mount by a knurled cap ring. To disassemble the Mount proceed as follows:

NOTE

Ser. 100 and below use 38B1 type 821 barretter; Ser. 101 and above use 38B3 type 560 barretter.

(1) Loosen setscrew (E).
(2) Remove knurled cap ring.
(3) Remove BNC trap, barretter and lower mounting post.
(4) Disassemble barretter from the BNC-trap assembly (A and B) and the lower mounting post (D).

NOTE

Reassemble the Mount as follows:

(5) Assemble BNC-trap assembly (A and B), barretter (C) and lower mounting post (D).
(6) Assemble to mount assuring that the lower mounting post is well into the lower aligning hole before tightening the knurled cap ring.

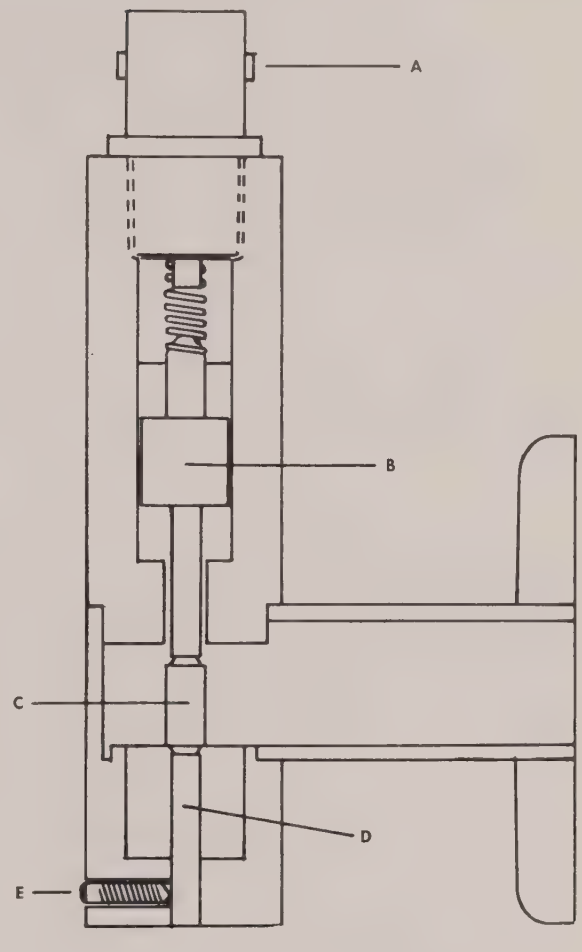


Figure 4-8. Replacing Bolometers in 33( )2 Series Mounts

SECTION V

PARTS LIST

5-1. GENERAL

5-2. This section provides a listing of the replaceable parts of the Power Meter. The listing contains the necessary information for the ordering of replacement parts. Parts are listed in alpha-numerical order of their reference designators in accordance with the designators assigned to these parts in the schematic diagrams included in this manual. Part nomenclature, with descriptive data for ordering purposes, are provided along with the Narda part number of each part.

5-3. To facilitate ordering of a replacement, parts are referenced to the selected list of manufacturers. (See tables 5-1 and 5-2.) A manufacturer's code number is included in the parts list for this purpose. The total quantity of each part installed in the Power Meter is also shown in the parts list. The replaceable parts list is presented in table 5-3.

5-4. ORDERING INFORMATION

5-5. If it is desired to order replacement parts from the instrument manufacturer, address the order to:

SALES DEPARTMENT
The Narda Microwave Corporation
Plainview, L.I., New York 11803

5-6. When ordering a part in this manner, the following information should be provided:
a. Model and serial number of the instrument
b. Narda part number
c. Reference designation
d. Description.

5-7. When ordering a part not listed in table 5-3, a complete description of the part, including its function and location, should be provided with the model and serial number of the instrument.

5-8. CUSTOMER REPAIR SERVICE

5-9. Repairs or recalibration of Narda Microline products are performed by the Customer Service Department at the factory; however, before returning any instrument, contact the Narda Microwave Corporation or the Narda Sales Representative in the area for shipping instructions. When requesting maintenance, complete the form provided at the rear of this manual.

Table 5-1. Manufacturer's Code (Code to Name)

Mfr. Fed. Supply Code	Name	Address
00656	Aerovox Corp.	New Bedford, Mass.
01121	Allen-Bradley Co.	Milwaukee 4, Wis.
01295	Texas Instruments, Inc.	Dallas, Texas
01807	Peterson Radio Co.	Council Bluffs, Iowa
02567	International Electronic Industries, Inc.	Nashville, Tenn.
02660	Amphenol Electronics Corporation	Chicago 50, Illinois
02735	RCA	Somerville, N.J.
03045	Ortho Filter Corp.	Paterson, N.J.
03508	General Electric Co.	Syracuse, N.Y.
03797	Eldema Corporation	El Monte, Calif.
03877	Transitron Electronic Corp.	Wakefield, Mass.
04009	Arrow, Hart and Hegeman Electric Co.	Hartford, Conn.
04221	Aemco, Inc.	Mankato, Minn.
04222	Hi-Q Division of Aerovox Corp.	Myrtle Beach, S.C.
04713	Motorola, Inc.	Phoenix, Ariz.
04941	Walsco Electronics Corp.	Rockford, Ill.
05277	Westinghouse Electric Corp.	Youngwood, Pa.
05624	Barber-Coleman Co.	Rockford, Ill.
06424	Sperry Microwave Electronics Co.	Clearwater, Fla.

Table 5-1. Manufacturer's Code (Code to Name) (Cont)

Mfr. Fed. Supply Code	Name	Address
06486	North American Electronics, Inc.	Lynn, Mass.
06555	Beede Electrical Instrument Co.	Penacook, N. H.
07065	Line Electric Co.	Newark, N. J.
07088	Kelvin Electric Co.	Van Nuys, Calif.
07115	Corning Glass Works	Bradford, Pa.
07263	Fairchild Semiconductor Corp.	Mountain View, Calif.
07387	Birtcher Corporation	North Los Angeles, Calif.
07688	Joint Electronic Tube Council (Jetec)	Washington, D. C.
08717	Sloan Co.	Burbank, Calif.
08914	Florida Transformer Co.	De Leon Spring, Fla.
09250	Electro Assemblies, Inc.	Chicago, Ill.
11903	MEC, Inc.	Nashville, Tenn.
12674	Synchro Corp.	Hicksville, Ohio
12697	Clarostat Mfg. Co.	Dover, N. H.
12954	Dickson Electronics Corp.	Scottsdale, Ariz.
13664	Workman Electronics	Sarasota, Fla.
14193	California Resistor Corp.	Santa Monica, Calif.
14655	Cornell-Dubilier Electric Corp.	South Plainfield, N. J.
15915	Tepro of Florida	Dunedin, Fla.
19701	Electra Mfg. Co.	Kansas City, Mo.
28520	Heyman Mfg. Co.	Kenilworth, N. J.
33173	General Electric Co.	Owensboro, Ky.
42190	Muter Company	Chicago 5, Ill.
44655	Ohmite Mfg. Co.	Skokie, Ill.
46859	Philco Corp.	Lansdale, Pa.
55933	Sonotone Corp.	Elmsford, N. Y.
56289	Sprague Electric Co.	North Adams, Mass.
58474	Superior Electric Co.	Bristol, Conn.
60437	Tower Mfg. Co.	Providence 3, R. I.
61577	Ultronix, Inc.	San Mateo, Calif.
65092	Daystrom Corp.	Newark, N. J.
70119	Advance Electric and Relay Co.	Burbank, Calif.
70485	Atlantic India Rubber Works, Inc.	Chicago, Ill.
70563	Amperite Co.	New York, N. Y.
70903	Belden Mfg. Co.	Chicago 44, Ill.
71002	Birnback Radio Co.	New York 13, N. Y.
71218	Bud Radio, Inc.	Cleveland, Ohio
71400	Bussman Mfg. Co.	St. Louis, Mo.
71450	CTS Corp.	Elkhart, Ind.
71590	Centralab Div. Globe Union, Inc.	Milwaukee 1, Wis.
71785	Cinch Mfg. Co.	Chicago 24, Ill.
72136	Electro Motive Mfg. Co.	Willimantic, Conn.
72259	Essex Electronics, Inc.	Berkley Heights, N. J.
72619	Dialight Corp.	Brooklyn 37, N. Y.
72765	Drake Mfg. Co.	Chicago 22, Ill.
72825	Hugh H. Eby, Inc.	Philadelphia, Pa.
72982	Erie Resistor Corp.	Erie 6, Pa.
73293	Hughes Products, Div. Hughes Aircraft Co.	Los Angeles, Calif.
73445	Amperex Electronics Corp.	Hicksville, N. Y.
74042	Merit Coil and Transformer Corp.	Hollywood, Fla.
74970	E. F. Johnson Co.	Waseca, Minn.
75042	International Resistance Co.	St. Petersburg. Fla.
75382	Kulka Electric Mfg. Co., Inc.	Mt. Vernon, N. Y.
75915	Littelfuse, Inc.	Des Plaines, Ill.
76487	James Millen Mfg. Co., Inc.	Malden, Mass.
76493	J. W. Miller Co.	Los Angeles, Calif.
76854	Oak Mfg. Co.	Chicago 10, Ill.
77342°	Potter and Brumfield, Inc.	Princeton, Ind.
77638	Radio Receptor Co., Inc.	Brooklyn, N. Y.
78488	Stackpole Carbon Co.	St. Marys, Pa.

Table 5-1. Manufacturer's Code (Code to Name) (Cont)

Mfr. Fed. Supply Code	Name	Address
78553	Tinnerman Products, Inc.	Cleveland, Ohio
79142	Veeder-Root, Inc.	Hartford, Conn.
80131	Electronic Industries Associates	Washington, D.C.
80207	Unimax Switch Div., W. L. Maxon Corp.	Wallingford, Conn.
80486	All Star Products, Inc.	Defiance, Ohio
80583	Harrarlund Co., Inc.	New York 1, N.Y.
81095	Traid Transformer Corp.	Venice, Calif.
81312	Winchester Electronics, Inc.	Norwalk, Conn.
81349	Military Specifications (MIL)	
81350	Joint Army-Navy Specifications (JAN)	
81483	International Rectifier Corp.	El Segundo, Calif.
81751	Columbus Electronics	Yonkers, N.Y.
82219	Sylvania Electronic Products, Inc.	Emporium, Pa.
82376	Astron Corp.	East Newark, N.J.
82389	Switchcraft, Inc.	Chicago 22, Ill.
82877	Rotron Mfg. Co., Inc.	Woodstock, N.Y.
83330	Herman H. Smith, Inc.	Brooklyn, N.Y.
84411	Good All Electric Mfg. Co.	Ogalialla, Nebr.
86684	R.C.A. Tube Division	Harrison, N.J.
88220	Gould-National Batteries, Inc.	St. Paul, Minn.
88419	Cornell-Cubilier Electric Corp.	Indianapolis, Ind.
91418	Radio Materials Co.	Chicago, Ill.
91459	Alcon Metal Products, Inc.	Chicago, Ill.
91637	Dale Electronics, Inc.	Columbus, Nebr.
91737	Gremar Mfg. Co., Inc.	Wakefield, Mass.
91802	Industrial Devices, Inc.	Edgewater, N.J.
93459	Weinschel Engineering Co.	Kensington, Md.
93970	W. Ralston and Co., Inc.	Old Bridge, N.J.
94154	Tung-Sol Electric, Inc.	Newark 4, N.J.
94990	Motorola, Inc.	Phoenix, Ariz.
95712	Dage Electric Co., Inc.	Beech Grove, Ind.
96253	Transformer Technician, Inc.	Chicago, Ill.
96906	Military Standards (MS)	
98687	Raytheon Mfg. Co.	Wayland, Mass.
99120	Plastic Capacitors, Inc.	Chicago, Ill.
99800	Delevan Electronics Corp.	East Aurora, N.Y.
99942	National Semiconductor Products	Evanston, Ill.
0000A	United International Dynamics Corp.	Waltham, Mass.

Table 5-2. Manufacturer's Code (Name to Code)

Name	Code
Advance Electric and Relay Co., Burbank, Calif.	70119
Aemco, Inc., Mankato, Minn.	04221
Aerovox Corp., New Bedford, Mass.	00656
Alcon Metal Products, Inc., Chicago, Ill.	91459
All Start Products, Inc., Defiance, Ohio	80486
Allen-Bradley Co., Milwaukee 4, Wis.	01121
Amperex Electronic Corp., Hicksville, N.Y.	73445
Amperite Co., New York, N.Y.	70563
Amphenol Electronics Corporation, Chicago, 50, Ill.	02600
Arrow, Hart, and Hegeman Electric Co., Hartford, Conn.	04009
Astron Corporation, East Newark, N.J.	82376
Atlantic India Rubber Works, Inc., Chicago, Ill.	70485
Barber-Colman Co., Rockford, Ill.	05624

Table 5-2. Manufacturer's Code (Name to Code) (Cont)

Name	Code
Beede Electrical Instrument Co., Penacook, N. H.	06555
Belden Mfg. Co., Chicago 44, Ill.	70903
Birnback Radio Company, New York 13, N. Y.	71002
Birtcher Corporation, North Los Angeles, Calif.	07387
Bud Radio Inc., Cleveland, Ohio	71218
Bussman Mfg. Co., St. Louis, Mo.	71400
California Resistor Corp., Santa Monica, Calif.	14193
Centralab Div. Globe Union, Inc., Milwaukee 1, Wis.	71590
Cinch Mfg. Co., Chicago 24, Ill.	71785
Clarostat Mfg. Co., Dover, N. H.	12697
Columbus Electronics, Yonkers, N. Y.	81751
CTS Corporation, Elkhart, Ind.	71450
Cornell-Dubilier Electric Corp., Indianapolis, Ind.	88419
Cornell-Dubilier Electric Corp., South Plainfield, N. J.	14655
Corning Glass Works, Bradford, Pa.	07115
Dage Electric Co., Inc., Beech Grove, Ind.	95712
Dale Electronics, Inc., Columbus, Nebr.	91637
Daystrom Corp., Newark, N. J.	65092
Delevan Electronics Corp., East Aurora, N. Y.	99800
Dialight Corporation, Brooklyn 37, N. Y.	72619
Dickson Electronics Corp., Scottsdale, Ariz.	12954
Drake Mfg. Co., Chicago 22, Ill.	72765
E. F. Johnson Co., Waseca, Minn.	74970
Eldema Corporation, El Monte, Calif.	03797
Electra Mfg. Co., Kansas City, Mo.	19701
Electro Assemblies, Inc., Chicago, Ill.	09250
Electro Motive Mfg. Co., Williamantic, Conn.	72136
Electronic Industries Associates, Washington, D. C.	80131
Erie Resistor Corporation, Erie 6, Pa.	72982
Essex Electronics, Inc., Berkley Heights, N. J.	72259
Fairchild Semiconductor Corp., Mountain View, Calif.	07263
Florida Transformer Co., DeLeon Spring, Fla,	08914
General Electric Co., Owensboro, Ky.	33173
General Electric Co., Syracuse, N. Y.	03508
Good All Electric Mfg. Co., Ogallala, Nebr.	84411
Gould-National Batteries, Inc., St. Paul, Minn.	88220
Gremar Mfg. Co., Wakefield, Mass.	91737
Hammarlund Co., Inc., New York 1, N. Y.	80583
Herman H. Smith, Inc., Brooklyn, N. Y.	83330
Heyman Mfg. Co., Kenilworth, N. J.	28520
Hi-Q Division of Aerovox Corp., Myrtle Beach, S. C.	04222
Hugh H. Eby, Inc., Philadelphia, Pa.	72825
Hughes Products Div. Hughes Aircraft Co., Los Angeles, Calif.	73293
Industrial Devices, Inc., Edgewater, N. J.	91802
International Electronics Industries, Inc., Nashville, Tenn.	02567
International Rectifier Corp., El Segundo, Calif.	81483
International Resistance Co., St. Petersburg, Fla.	75042
James Millen Mfg. Co., Inc., Malden, Mass.	76487
Joint Army-Navy Specifications (JAN)	81350
Joint Electronic Tube Council (Jetec), Washington, D. C.	07688
J. W. Miller Co., Los Angeles, Calif.	76493
Kelvin Electric Co., Van Nuys, Calif.	07088
Kulka Electric Mfg. Co., Inc., Mt. Vernon, N. Y.	75382
Line Electric Company, Newark, N. J.	07065
Littelfuse, Inc., Des Plaines, Ill.	75915
MEC, Inc., Nashville, Tenn.	11903
Merit Coil and Transformer Corporation, Hollywood, Fla.	74042
Military Specifications (MIL)	81349
Military Standards (MS)	96906
Motorola, Inc., Phoenix, Ariz.	94990

Table 5-2. Manufacturer's Code (Name to Code) (Cont)

Name	Code
Motorola, Inc., Phoenix, Ariz.	04713
Muter Company, Chicago 5, Ill.	42190
National Semiconductor Products, Evanston, Ill.	99942
North American Electronics, Inc., Lynn, Mass.	06486
Oak Mfg. Co., Chicago 10, Ill.	76854
Ohmite Mfg. Co., Skokie, Ill.	44655
Ortho Filter Corp., Paterson, N.J.	03045
Peterson Radio Co., Council Bluffs, Iowa	01807
Philco Corp., Lansdale, Pa.	46859
Plastic Capacitors, Inc., Chicago, Ill.	99120
Potter and Brumfield, Inc., Princeton, Ind.	77342
Radio Materials Co., Chicago, Ill.	91418
Radio Receptor Co., Inc., Brooklyn, N.Y.	77638
Raytheon Mfg. Co., Wayland, Mass.	98687
RCA, Somerville, N.J.	02735
RCA Tube Division, Harrison, N.J.	86684
Rotron Mfg. Co., Woodstock, N.Y.	82877
Sloan Co., Burbank, Calif.	08717
Sonotone Corp., Elmsford, N.Y.	55933
Sperry Microwave Electronics Company, Clearwater, Fla.	06424
Sprague Electric Co., North Adams, Mass.	56289
Stackpole Carbon Co., St. Marys, Pa.	78488
Superior Electric Co., Bristol, Conn.	58474
Switchcraft, Inc., Chicago 22, Ill.	82389
Sylvania Electric Products, Inc., Emporium, Pa.	82219
Synchro Corporation, Hicksville, Ohio	12674
Tepro of Florida, Dunedin, Fla.	15915
Texas Instruments, Inc., Dallas, Texas	01295
Tinnerman Products, Inc., Cleveland, Ohio	78553
Tower Mfg. Co., Providence 3, R.I.	60437
Transformer Technician, Inc., Chicago, Ill.	96253
Transitron Electronic Corp., Wakefield, Mass.	03877
Triad Transformer Corporation, Venice, Calif.	81095
Tung-Sol Electric, Inc., Newark 4, N.J.	94154
Ultronix, Inc., San Mateo, Calif.	61577
Unimax Switch Div., W.L. Maxon Corp., Wallingford, Conn.	80207
United International Dynamics Corp., Waltham, Mass.	0000A
Veeder-Root, Inc., Hartford, Conn.	79142
W. Ralston and Co., Inc., Old Bridge, N.J.	93970
Walsco Electronics Corp., Rockford, Ill.	04941
Weinschel Engineering Co., Kensington, Md.	93459
Westinghouse Electric Corp., Youngwood, Pa.	05277
Winchester Electronics, Inc., Norwalk, Conn.	81312
Workman Electronics, Sarasota, Fla.	13664

Table 5-3. Replaceable Parts List

Reference Designation	Name	Mfr. Code	Narda Part No.	Quantity per Unit
BT1	BATTERY: Nickel-Cadmium, Rechargeable, 24.0 volts nominal	55933	C-02920	1
C1	CAPACITOR: Fixed, Disc, 0.1 uf, ±20%, 25 vdc	91418	80123-009	4
C2	Same as C1			
C3	Same as C1			
C4	CAPACITOR: Fixed, Disc Ceramic, 0.05 uf, +80%, -20%, 200 vdc	56289	80123-015	1
C5	CAPACITOR: Fixed, 4700 uuf, ±15%, 300 vdc	72982	80122-033	1
C6	CAPACITOR: Fixed, Electrolytic, 100 uf, -10%, +100%, 25 vdc	11903	80121-010	1
C7	CAPACITOR: Fixed, Electrolytic, 50 uf, -10%, +100%, 50 vdc	88419	80120-018	2
C8	Same as C7			
C9	CAPACITOR: Fixed, Electrolytic, 30 uf, -10%, +25%, 150 vdc	00656	80120-022	1
C10	CAPACITOR: Fixed, Electrolytic, 50 uf, -10%, +100%, 25 vdc	88419	80121-028	2
C11	CAPACITOR: Fixed, Electrolytic, 10 uf, -10%, +100%, 25 vdc	88419	80121-024	1
C12	CAPACITOR: Fixed, Electrolytic, 250 mfd, 25 vdc		80120-013	
C13	CAPACITOR: Fixed, Disc, 0.05 uf, -20%, +80%, 100 vdc	91418	80123-015	1
C14	CAPACITOR: Fixed, Mica, 390 uuf, ±5%, 300 vdc	93970	80115-041	1
C15	CAPACITOR: Fixed, Disc, 0.1 uf, +80%, -20%, 100 vdc	91418	80123-009	1
C16	CAPACITOR: Fixed, Mica, 150 uuf, ±5%, 500 vdc	93970	80115-031	1
C17	CAPACITOR: Fixed, Disc, 1 uf, ±20%, 25 vdc	56289	A-01214-105	8
C18	CAPACITOR: Fixed, Disc Ceramic, 0.05, +80%, -20%, 500 vdc	14655	80123-015	1
C19	CAPACITOR: Fixed, Disc Ceramic, 0.01 mfd		80123-013	1
C51	CAPACITOR: Fixed, Disc Ceramic, 0.005 uf, +80%, -20%, 500 vdc	14655	80128-003	3
C52	Same as C51			
C53	Same as C51			
C105	CAPACITOR: Fixed, Mylar, 0.022 uf, ±20%, 200 vdc	00656	80127-006	2
C109	Same as C17			
C110	CAPACITOR: Fixed, Electrolytic, 15 uf, +100%, -10%, 20 vdc	56289	80125-040	3
C111	CAPACITOR: Fixed, Mica, 10 uuf, ±5%, 300 vdc	93970	80115-008	1
C112	Same as C110			
C113	Dame as C17			
C114	Same as C110			
C154	Same as C105			
C201	Same as C17			
C202	CAPACITOR: Fixed, Mica, 270 uuf, ±5%, 500 vdc	93970	80115-051	1
C204	CAPACITOR: Fixed, Electrolytic, 60 uf, +100%, -10%, 6 vdc	56289	80125-009	2
C205	Same as C17			
C206	Same as C17			
C208	Same as C17			
C215	Same as C204			
C217	CAPACITOR: Fixed, Mica, 33 uuf, ±5%, 300 vdc	93970	80115-017	1
C250	Same as C17			
CR2	SEMICONDUCTOR Diode, 1N3022A	04713	84514-009	1
CR3	SEMICONDUCTOR Diode, 1N645	82219	84512	
CR4	SEMICONDUCTOR Diode, 1N914	03877	84505	3
CR5	SEMICONDUCTOR Diode, 1N538	04713	84522-006	5

Table 5-3. Replaceable Parts List (Cont)

Reference Designation	Name	Mfr. Code	Narda Part No.	Quantity per Unit
CR6	Same as CR5			
CR7	Same as CR5			
CR8	Same as CR5			
CR9	Same as CR5			
CR10	SEMICONDUCTOR Diode, 1N963B	99942	84507-102	1
CR11	SEMICONDUCTOR Diode, 1N754	12954	84511-009	2
CR12	SEMICONDUCTOR Diode, 1N823	04713	84502-002	1
CR13	SEMICONDUCTOR Diode, 1N270	82219	84512	1
CR14	Same as CR4			
CR15	SEMICONDUCTOR Diode, 1N457	01295	84508-002	6
CR201	Same as CR11			
CR202	SEMICONDUCTOR Diode, 1N758	03877	84511-013	1
CR203	Same as CR5			
CR204	Same as CR15			
CR16				
CR205	Diode, 1N753A	03877	632638-208	1
DS1	LAMP: Neon, Red	72765	A-01853-102	1
F1	FUSE: 0.250 amp, 125 v	71400	81002-010	1
FL201	FILTER: RF1, Ferrite Ceramic, 3000 pf min, 500 vdc			
J1	JACK: Phone	82389	A-01731-2	1
J2	CONNECTOR: Panel Mount, BNC	95712	A-01754-4	2
J3	Same as J2			
J4	CONNECTOR: Power	60437	A-01735-5	1
L1	CHOKE: 33 uh	99800	84602-031	2
L101	Same as L1			
L201	CHOKE: 68 uh nom		84602	
M1	METER: 0-1 ma, internal shunt for 0-10 ma	65092	A-02514	1
Q1	TRANSISTOR: 2N834	03508	89003-001	8
Q2	TRANSISTOR: 2N964	04713	89002-002	3
Q3	Same as Q1			
Q4	Same as Q1			
Q5	Same as Q1			
Q6	TRANSISTOR: 2N2270	05277	89007	6
Q7	Same as Q6			
Q8	Same as Q6			
Q9	TRANSISTOR: 2N1479	02735	89001	1
Q10	Same as Q6			
Q11	Same as Q6			
Q12	Same as Q6			
Q13	Same as Q1			
Q104	Same as Q1			
Q105	Same as Q1			
Q106	Same as Q2			
Q201	TRANSISTOR: 2N3964		89009	
Q202	Same as Q2			
Q203	Same as Q1			
R1	RESISTOR: Fixed, Deposited Metal Film, 2.2k, ±1%, 1/4 w	75042	83048-225	2
R3	RESISTOR: Fixed Deposited Metal Film, 1.5k, ±1%, 1/4 w	75042	83048-209	2
R4	Same as R1			
R5	RESISTOR: Fixed, Composition, 2.2k, ±5%, 1/2 w	78488	83018-057	4
R6	RESISTOR: Fixed, Composition, 3.3k, ±5%, 1/2 w	78488	83018-061	4
R7	Same as R6			
R8	Same as R6			
R9	RESISTOR: Fixed, Composition, 7.5k, ±5%, 1/2 w	78488	83018-070	1
R10	RESISTOR: Fixed, Composition, 5.6k, ±5%, 1/2 w	78488	83018-067	1
R11	RESISTOR: Fixed, Composition, 470 ohms, ±5%, 2 w	78488	83011-041	1

Table 5-3. Replaceable Parts List (Cont)

Reference Designation	Name	Mfr. Code	Narda Part No.	Quantity per Unit
R12	RESISTOR: Fixed, Composition, 120 ohms, ±5%, 1/2 w	78488	83018-027	
R13	RESISTOR: Fixed, Composition, 68k, ±5%, 1/2 w	78488	83018-093	1
R14	RESISTOR: Fixed, Deposited Metal Film, 750 ohms,	75042	83048-181	1
R15	RESISTOR: Fixed, Deposited Metal Film, 2k, ±1%, 1/8 w	75042	83048-222	1
R16	RESISTOR: Fixed, Composition, 6.8k, 2.4k, 2 w 5%	78488	83011-058	1
R17	RESISTOR: Fixed, Composition, 820 ohms, 470 ohms, 6.5 w	44655	83042-089	1
R18	RESISTOR: Fixed, Composition, 4.7k, ±5%, 1/2 w	78488	83018-065	1
R19	RESISTOR: Fixed, Composition, 10k, ±5%, 1/2 w	78488	83018-073	3
R20	RESISTOR: Fixed, Composition, 2.7k, ±5%, 1/2 w	78488	83018-059	1
R21	RESISTOR: Fixed, Deposited Metal Film, 10k, ±1%, 1/4 w	75042	83048-288	1
R22	RESISTOR: Fixed, Deposited Metal Film, 3.32k, ±1%, 1/4 w	75042	83048-242	1
R23	RESISTOR: Fixed, Deposited Metal Film, 1.21k, ±1%, 1/4 w	75042	83048-200	1
R24	RESISTOR: Fixed, Deposited Metal Film, 11k, ±1%, 1/4 w	75042	83048-292	1
R25	RESISTOR: Fixed, Deposited Metal Film, 4.99k, ±1%, 1/4 w	75042	83048-259	1
R26	RESISTOR: Variable, 2k, 1/4 w	71450	B-02158-202	1
R27	RESISTOR: Fixed, Deposited Metal Film, 47.5k, ±1%, 1/4 w	75042	83048-352	1
R28	RESISTOR: Fixed, Deposited Metal Film, 22.1k, ±1%, 1/4 w	75042	83048-320	1
R29	RESISTOR: Fixed, Deposited Metal Film, 121k, ±1%, 1/4 w	75042	83048-391	1
R30	RESISTOR: Variable, 150k, 0.2 w	71450	B-02158-154	1
R31	RESISTOR: Variable, 50k, 0.2 w	71450	B-02158-503	1
R32	RESISTOR: Variable, 75k, 0.2 w	71450	B-02158-753	1
R33	RESISTOR: Fixed, Composition, 1k, ±5%, 1/2 w	78488	83018-049	4
R34	RESISTOR: Fixed, Composition, 100 ohms, ±5%	78488	83018-025	1
R35	RESISTOR: Fixed, Composition, 22k, ±5%, 1/2 w	78488	83018-081	2
R36	Same as R6			
R37	RESISTOR: Fixed, Composition, 8.2k, ±5%, 1/2 w	78488	83018-071	1
R38	Same as R33			
R39	RESISTOR: Fixed, Composition, 4.3k, ±5%, 1/2 w	78488	83018-064	1
R40	Same as R5			
R41	Same as R5			
R42	RESISTOR: Fixed, Composition, 27k, ±5%, 1/2 w	78488	83018-083	1
R43	Same as R19			
R51	RESISTOR: Fixed, Composition, 100k, 1/2 w 5%		83018-097	
R103	RESISTOR: Variable, Wirewound, 250 ohms, ±10%, 2 w	71450	A-01189-251	1
R106	RESISTOR: Deposited Metal Film, 100 ohms, ±1%, 1/4 w	75042	83048-097	1
R112	RESISTOR: Deposited Metal Film, 200 ohms, ±1%, 1/4 w	75042	83048-126	1
R118	RESISTOR: Deposited Metal Film, 619 ohms, ±1%, 1/4 w	75042	83048-173	1
R119	RESISTOR: Deposited Metal Film, 6.04k, ±1%, 1/4 w	75042	83048-267	1
R120	RESISTOR: Deposited Metal Film, 6.81k, ±1%, 1/4 w	75042	83048-272	2
R123	RESISTOR: Fixed, Composition, 510 ohms, ±5%, 1/2 w	78488	83018-042	1

Table 5-3. Replaceable Parts List (Cont)

Reference Designation	Name	Mfr. Code	Narda Part No.	Quantity per Unit
R124	RESISTOR: Variable, Composition, 3.5k, ±10%, 2 w	12697	A-01168-352	1
R125	Same as R33			
R126	Same as R33			
R127	RESISTOR: Fixed, Composition, 300 ohms, ±5%, 1/2 w	78488	83018-036	1
R128	Same as R5			
R129	RESISTOR: Fixed, Composition, 820 ohms, ±5%, 1/2 w	78488	83018-047	1
R152	RESISTOR: Fixed, Composition, 510 ohms, ±5%, 1/2 w	78488	83018-042	1
R201	Same as R3			
R202	RESISTOR: Fixed, Deposited Metal Film, 1.43k, ±1%, 1/4 w	75042	83048-207	1
R203	RESISTOR: Fixed, Deposited Metal Film, 866 ohms, ±1%, 1/4 w	75042	83048-186	2
R204	RESISTOR: Fixed, Deposited Metal Film, 2.49k, ±1%, 1/4 w	75042	83048-230	1
R205	RESISTOR: Fixed, Deposited Metal Film, 6.2k, ±1%, 1/4 w	75042	83048-268	1
R207	RESISTOR: Fixed, Deposited Metal Film, 806 ohms, ±1%, 1/4 w	75042	83048-184	1
R208	RESISTOR: Fixed, Deposited Metal Film, 200 ohms, ±1%, 1/4 w	75042	83048-126	1
R209	RESISTOR: Fixed, Deposited Metal Film, 10 ohms, ±1%, 1/4 w	75042	83048-001	1
R210	RESISTOR: Fixed, Deposited Metal Film, 84.5 ohms, ±1%, 1/4 w	75042	83048-090	1
R211	RESISTOR: Fixed, Deposited Metal Film, 1k, ±1%, 1/4 w	75042	83048-192	1
R213	RESISTOR: Deposited Metal Film, 3.32k, ±1%, 1/4 w	75042	83048-242	
R214	RESISTOR: Fixed, Deposited Metal Film, 886 ohms, ±1%, 1/4 w	75042	83048-186	1
R215	RESISTOR: Fixed, Deposited Metal Film, 243 ohms, ±1%, 1/4 w	75042	83048-134	1
R216	RESISTOR: Fixed, Deposited Metal Film, 61.9 ohms, ±1%, 1/4 w	75042	83048-077	1
R217	RESISTOR: Fixed, Deposited Metal Film, 30.9 ohms, ±1%, 1/4 w	75042	83048-048	1
R221	RESISTOR: Variable, Composition, 500 ohms, ±10%, 2 w	71450	A-01151-501	1
R222	RESISTOR: Variable, Composition, 2.5k, ±10%, 2 w	71450	A-01151-252	1
R230	RESISTOR: Fixed, Composition, 1.2k, ±5%, 1/2 w	78488	83018-051	1
R231	RESISTOR: Fixed, Deposited Film, 232 ohms, ±1%, 1/4 w	75042	83048-132	1
R232	RESISTOR: Fixed, 22k, 1/2 w, 5%		83018-081	
S1	SWITCH: Rotary, Single Wafer, 60 degree index, 4 position	71590	B-02676-3	1
S2	SWITCH: Rotary, 3 wafer, 30 degree index, 3 position	71450	B-02682	1
S3	SWITCH: Rotary, Single Wafer, 30 degree index, 1 pole, 4 position	71450	B-02681	1
S4	SWITCH: Rotary, Single Wafer, 30 degree index, 3 pole, 3 position	71590	B-02659-1	1
S5	SWITCH: Slide, DPDT	78488	83509	1
T1	TRANSFORMER: Power	74042	A-02421	1
XF1	FUSEHOLDER	71400	81003-101	1